Branner.

Ph. D.,

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ANNUAL REPORT

OF THE

GEOLOGICAL SURVEY

OF

ARKANSAS,

FOR 1891.

VOLUME II.

MISCELLANEOUS REPORTS.

THE GEOLOGY OF BENTON COUNTY by F. W. Simonds and T. C. Hopkins.
ELEVATIONS IN THE STATE OF ARKANSAS by John C. Branner.
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THE MOLLUSCA OF ARKANSAS by F. A. Sampson.
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JOHN C. BRANNER, Ph. D.,
State Geologist.

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OFFICE OF THE GEOLOGICAL SURVEY OF ARKANSAS,
LITTLE ROCK, Dec. 27, 1892.

To His Excellency,
Hon. James P. Eagle,
Governor of Arkansas.

Sir:

I have the honor to submit herewith Volume II. of my annual report for 1891, and to remain,

Your obedient servant,
JOHN C. BRANNER,
State Geologist.

ELEVATIONS IN THE STATE OF ARKANSAS.

BY JOHN C. BRANNER.

OBSERVATIONS ON THE EROSION OF THE ARKANSAS RIVER ABOVE LITTLE ROCK.

BY JOHN C. BRANNER.

MAGNETIC OBSERVATIONS AND MERIDIAN MONUMENTS ESTABLISHED IN ARKANSAS.

BY JOHN C. BRANNER.

A PRELIMINARY LIST OF THE MOLLUSCA OF ARKANSAS.

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A CATALOGUE OF THE FISHES OF ARKANSAS.

BY SETH EUGENE MEEK, PH. D.

THE GEOLOGY OF DALLAS COUNTY.

BY C. E. SIEBENTHAL, A. M.

ERRATA.

Page.	Line.	*Miscellaneous Reports.*
8	16	"120 feet below Bentonville" should be *80 feet below Dickson.*
8	17	"180" should be *140.*
108	43	elevation of West Memphis should be 220.70.
144	10	"verticle" should be *vertical.*
155	Foot-note	"R. N. Beackett" should be *R. N. Brackett.*
182	4–5	"Randolph; Hot Springs, Garland" should be *Warm Springs, Randolph.*
196	4	"*vicarinatus*" should be *bicarinatus.*
204	25	"Okolono" should be *Okolona.*
241	25	"*illicebrosus*" should be *illecebrosus.*
246	13, 18	"*umbratilus*" should be *umbratilis.*
248	26	"*Hypopsis*" should be *Hybopsis.*
249	4	"*H. Wautauga*" should be *H. watauga.*
252	28	"*Dorosowa*" should be *Dorosoma.*
255	18	"*Vermiculatns*" should be *Vermiculatus.*
259	last	"lap" should be *flap.*
281	7	from bottom "interspperced" should be *interspersed.*
283	23	"Wiley Canler" should be *Wiley Cabler.*
300	5	from bottom, foot-note, "Al_2O_3. SiO_2. $3H_2O$," should be Al_2O_3. $2SiO_2$. $3H_2O$.
301		in table, percentage of soda should be .297.

THE GEOLOGY OF BENTON COUNTY.

By Frederic W. Simonds and T. C. Hopkins.

CHAPTER I.

Topographic Features.

The rocks of Benton county, like those of Washington county, are limestones, cherts, sandstones, and shales, lying for the most part in horizontal beds, in consequence of which there is a continuation of the topographic features already described in the report on Washington county in Vol. IV of the report of this Survey for 1888, viz.: gullies and gorges with flint-covered slopes, valleys, oftentimes with abrupt walls or bluffs, and flat-topped hills and mountains. West of the St. Louis and San Francisco Railway the surface is not so broken as it is in Washington county on the south. Topographically it may be regarded as a great plain deeply furrowed, on the north and west by valleys tributary to the Elk and Neosho Rivers, and on the south by the valleys of the Illinois River and its tributaries. East of the railway White River and various streams flowing into it have excavated deep channels, and the intervening water-sheds are often of sufficient height to attain the dignity of mountains.

PRAIRIES.

There are a number of small prairies in Benton county, the more important of which are here briefly described.

Osage Prairie.—In shape Osage Prairie is very irregular, its longest direction being east and west. Beginning near and north of Rogers in 19 N., 30 W., section 1, it extends westward, passing just south of Bentonville, for ten miles, into 19

N., 31 W., section 4. From this point it extends in a west of south direction for three miles or more. Its greatest width, which is directly south of Bentonville, does not exceed two and a quarter miles, and usually it is much less. It is traversed by the Rogers-Bentonville road and also for a considerable distance by the Bentonville Railway. The level character of this tract is well shown by the fact that the difference in elevation between Bentonville and Rogers is less than 100 feet.

Beatie Prairie.—Beatie Prairie lies partly within Benton county, extending from the line of Indian Territory in a northeast direction across 20 N., 34 W., and ending in 20 N., 33 W., section 6. Its length, within the state, is about six miles; its greatest breadth is on the territory line, where it is over two miles wide. The roads entering Maysville from the northeast and east traverse this prairie, a portion of which is not yet enclosed.

Round Prairie.—Round Prairie is in the western part of the county, between Bloomfield and Cherokee City. It occupies the southwestern portion of 19 N., 33 W.; the northeast corner of 18 N., 34 W.; and the southeast corner of 19 N., 34 W. Its length, in a north of east and south of west direction, is about four miles, and its greatest breadth, on the range line west of Bloomfield, is two and a half miles.

Lindsley's Prairie.—Lindsley's Prairie is in the southwest portion of the county, adjacent to the state line; it lies north, northeast, east, and southeast of the town of Siloam Springs. The larger part of this prairie is in 18 N., 33 W., extending on the west into the southeast corner of 18 N., 34 W., and on the south into the northern half of 17 N., 33 W. Its length, in a northeast and southwest direction, is between five and six miles; its breadth, in a northwest and southeast direction, over four miles.

Smaller prairies.—In addition to the above named prairies, which include the larger level areas, there are many smaller tracts; as, for example, one in the southeast quarter of 19 N., 30 W., a little southwest of Rogers; one in Mason's Valley, southwest of Bentonville; and others at intervals along the

the Illinois River in the southwest part of the county, near the Benton-Washington county line.

VALLEYS.

Even in a comparatively undisturbed region, such as North Arkansas, erosion gives rise to many surface irregularities. The valleys are, as a rule, deep and narrow, with high banks and not infrequently precipitous walls. In Benton county the larger valleys are those excavated by the Illinois and White Rivers. Among the smaller valleys those of Little Sugar, Butler, and Honey Creeks in the northern part of the county; Spavinaw and Flint Creeks in the western part; Big and Little Osage Creeks in the southern part; and Little Clifty, Prairie, Spider, and Indian Creeks in the eastern part, are worthy of mention. A detailed account of the streams flowing through these valleys will be found in the chapter on hydrography.

MOUNTAINS.

West of the St. Louis and San Francisco Railway there are only a few points at which rocks overlying the Boone chert occur, the most important of which are Big Mountain, Little Mountain, and the neighboring elevations in the southwestern part of 21 N., 28 W. The first mentioned is the sandstone-capped eminence near Elk Horn Tavern, in 21 N., 29 W., sections 26, 25, and 36. The name "Pea Ridge" is applied to the general plateau upon which the mountains rest, and which embraces the area between Garfield and the town of Pea Ridge. Northeast of Garfield, the railway runs well up on the Devil's Eyebrow, a north-south ridge of Batesville sandstone lying in 21 N., 28 W., the northwest quarter of section 27, and the southwest quarter of section 22, facing, on its east side, the deeply eroded canyons of Indian Creek. The view from this point is extensive and gives an excellent illustration of the immense erosive action of the White River and its tributaries.

Southwest of Lowell, in 18 N., 30 W., on the line between sections 14 and 15, there is an isolated elevation known as Cal-

lahan Mountain. Its height above that station is 170 feet.* Again, southwest of Robinson, in 17 N., 32 W., on the left bank of the Illinois River, there are two peaks, known respectively as Upper and Lower Round Top.

There are also other well marked topographic features not rising above the Boone chert, such as the hills in the vicinity of Sulphur Springs, in the northwest part of the county.

That portion of the county east of the St. Louis and San Francisco Railway is very rugged. Along the line of the water-shed between the headwaters of Big and Little Sugar Creeks and the tributaries of White River are several topographic prominences of the same general character as those of the Pea Ridge area, of which they may be considered a part. Blansett Mountain, just south of Garfield, is one of these; it lies on the township line, a part being in 21 N., 28 W., sections 32 and 33, and a part in 20 N., 28 W., sections 4 and 5. The Batesville sandstone caps its summit, and beneath this the Fayetteville shale and the Boone chert are exposed. The railway skirts its northern and western flanks, as does also the wagon road leading southwest from Garfield. Directly east of Blansett Mountain, in 21 N., 28 W., sections 33 and 34, is another small sandstone elevation, Gentry Mountain, and two miles south of it and a half mile west, in 20 N., 28 W., section 17, the south half, and section 20, the north half, there is a similar elevation know as Ratcliff or Posey Mountain. Between the headwaters of Little Sugar Creek on the north, those of Ventry Branch on the south, and Ford Creek on the east, is a sandstone area known as Humphrey's or Pond Mountain (sections 9, 10, 15, and 16), separated from Rich or Ellis Mountain (sections 2 and 11) by a narrow exposure of the chert. Ellis Mountain, while resembling the other sandstone-capped elevations of this vicinity, lies almost, if not entirely, within the drainage area of White River. Poor Mountain, in sections 13 and 14, is the most prominent peak in the county, and is visible from Eureka Springs and from other high points in Carroll county. It forms the divide between Ford Creek on the

*Unless otherwise stated the measurements given are barometric.

east, Indian Creek on the north, and Fish Trap Hollow on the south. Its height is estimated at 1820 feet above the sea-level. It is 600 feet above White River at Jennings Ford. The view from the summit of Poor Mountain is obstructed by the timber; nevertheless occasional vistas open to the east and show in the foreground the deep valley of White River, with the hills and mountains of Carroll county in the distance. From Mr. Whitney's place on the south side of the mountain, just below the summit, an extended view may be had: to the south and southeast, in the immediate foreground, are deep hollows draining eastward into White River; farther to the south the land appears to rise to the general level of the Benton county plateau, while the Boston Mountains are visible on the distant horizon. South of west Ratcliff Mountain is the most prominent feature, and north of west, Humphrey's Mountain.

Between Indian and Spider Creeks, in 21 N., 27 W., section 19, and 21 N., 28 W., section 24, and 21 N., 27 W., section 30, is an elevation known as Little Sugar Mountain. Its highest point, which is near the middle of section 30, mostly in the northwest quarter, is estimated at 1770 feet above sea-level.

TOPOGRAPHY OF SPECIAL LOCALITIES.

In the vicinity of Bentonville.—South, southeast, and southwest of Bentonville lies the Osage Prairie region. To the northwest is the elevated Pea Ridge region, with the intervening area broken by the valleys of Little Sugar Creek and its tributaries. To the north and northwest these valleys are more deeply eroded. From the depth of Little Sugar Creek valley it will readily be seen that, even though the strata are comparatively horizontal, the lateral valleys of erosion give the country a rugged aspect.

Elevations on the Bentonville-Pineville road.

	Feet below Bentonville.	Elevation above tide.
20 N., 30 W., section 19, northwest quarter	170	1132
20 N., 31 W., section 12, ford on Jackson's Creek	250	1052
21 N., 31 W., section 35, first ford on Little Sugar Creek	310	992
21 N., 31 W., section 23, ford on Little Sugar Creek	320	982
Last ford on Little Sugar Creek in Arkansas	330	972
Ford on Little Sugar Creek at Caverna, Missouri	345	957

The Bentonville-Maysville road--by way of Seba post-office—descends into a ravine 150 feet below the Bentonville level, about one mile west of Bentonville. Near the east line of section 34 the elevation is only about 25 feet lower than Bentonville, and the country is a gently rolling one. The road passes over the edges of arenaceous and limestone strata into the bed of a creek 90 feet below Bentonville in the north half of section 34, and after an ascent of the opposite bank traverses a flat area, following the line between sections 28 and 33, and 29 and 32, where the altitude is somewhat higher than at Bentonville--50 feet at Seba post-office, and 90 feet in section 30. At this point the country to the west appears to be somewhat broken. Continuing now in a general northwest course for several miles, the road follows the divide between the headwaters of Spavinaw Creek, and finally enters the valley of that stream over a mile above Patton's mill. Spavinaw valley is one of a series of valleys in the western and southwestern parts of the county, having a south of west or southwest trend. On the road to Nebo, north of Spavinaw valley, in 20 N., 32 W., section 20, the west half, there is a rapid ascent to the general level of the country, which is 50 feet above Bentonville. Nebo, in 20 N., 33 W., section 13, the northeast quarter, and extending into section 12 on the north, is situated in a valley approximately at the Bentonville level. The ford of Little Spavinaw Creek, near Bethel Church on the Nebo-Decatur road, is 120 feet below Bentonville; but in 19 N., 33 W., section 1, the valleys are only 90 and 70 feet respectively; and Decatur, in section 11, the southeast quarter, is approximately on the same level as Bentonville.

The road from Bentonville to Decatur has a general course a little south of west, and for five or six miles it crosses a level prairie region. Even the valley of the Dry Fork of the Spavinaw, 19 N., 32 W., section 7, is but 55 or 60 feet below Bentonville.

Southwest of Bentonville.—The roads from Bentonville to Bloomfield and Siloam Springs, the last named by way of Mason Valley and Springtown, traverse the county in a general

southwest direction from Bentonville. Turning south from the Decatur road in 19 N., 31 W., section 2, the southeast quarter, the elevation is about 25 feet lower than that of Bentonville; a mile to the south, in section 11, it is 45 feet below; at the southwest corner of the section, 50 feet; and at the ford of Mitchell's Branch of Little Osage Creek, in section 15, 80 feet.

South of Bentonville.—The region south of Bentonville is traversed by three roads. On the eastern road in one instance only are strata encountered occupying a position above the Boone chert,—at Callahan Mountain, in 18 N., 30 W., on the line between sections 14 and 15, which is an outlying hill in all respects similar to those east and northeast of Springdale on and near the Benton-Washington county line. Depressions of course occur, but they never attain sufficient depth to cut through the limestone and chert. The most marked examples are the valleys of Big Osage Creek, crossed in 19 N., 30 W., section 16, 30 feet below Bentonville; and of Spring Creek, in 18 N., 30 W., section 22, 55 feet below Bentonville. These figures do not, however, give the depths of these valleys in their relation to the adjacent country. For instance, the ford of Big Osage Creek, as above given, is 60 feet below the adjoining hill; and the ford of Spring Creek is 145 feet below the foot of Callahan Mountain. The other levels noted on this (Bentonville-Springdale) road, referred to Bentonville as a base, are as follows: in 19 N., 30 W., at the half section line, on the east of section 8, 0; at the northwest corner of section 27, 20 feet above; in the centre of section 34, 50 feet above; in 18 N., 30 W., section 3, the northwest corner of the northeast quarter, 50 feet above; section 3, the northeast corner, 50 feet above; near Union School, in section 11, 50 feet above; at the base of Callahan Mountain, in section 15, 90 feet above; at the north line of section 22, 50 feet above; at Spring Creek in section 22, 55 feet below; at Cross Roads (Washington county), section 27, 50 feet above; and at Springdale, 35 feet above.

The Bentonville-Elm Springs road passes over a region varying but little from the Bentonville level until the valleys of Little and Big Osage Creeks are encountered, where the sur-

face becomes quite irregular and is usually covered with chert debris. Adjoining Little Osage Creek are alluvial bottomlands, but the sloping sides of the valley are flinty.

The Pea Ridge region.—At the level of Elk Horn Tavern, 275 feet above Bentonville, and at the foot of Big Mountain, the Boone chert prevails, followed, in ascending the mountain, by the Fayetteville shale, which in its turn is succeeded by a heavy cap of Batesville sandstone. The highest point is approximately 380 feet above Bentonville. East of Big Mountain, less than two miles distant, are the smaller elevations known as Williams, Henry, and Glasscock Mountains, while Blansett Mountain, at Garfield, is less than three miles away in a south of east direction, and the Devil's Eyebrow but four miles, in a direction north of east.

Sulphur Springs and vicinity.—Hopkins' Spring, on the Bentonville-Sulphur Springs road, is about 120 feet below Bentonville, while in 21 N., 32 W., section 35, the road is 180 feet below Bentonville. In section 34, however, the surface is somewhat higher, and the top of the hill overlooking the valley of Seiler's Branch, a tributary of Butler Creek, is only about 60 feet below Dickson. After entering this valley the road descends 200 feet in less than a quarter of a mile; Mr. Seiler's spring, two and a half miles from Sulphur Springs, in 21 N., 32 W., section 30, is over 300 feet below the elevation of Dickson. This spring is in the Eureka shale at the base of the Boone chert. The valley of Butler Creek, which has cut still deeper into the underlying Silurian rocks, opens towards the northwest and is so enclosed by hills that it requires an abrupt ascent to leave it in any other direction. The town of Sulphur Springs is situated in this valley about the springs which have given it their name (21 N., 33 W., section 23, the southeast quarter). Round Top and other hills in the vicinity of Sulphur Springs are marked topographic features.

Nebo is estimated to be over 300 feet higher than Sulphur Springs.

The ford on the West Fork of Butler Creek near the Baptist church in 21 N., 33 W., the center of section 15, is 75 feet be-

low Sulphur Springs. On the hill west of the church the Eureka shale occurs 15 feet above the creek, and is overlain by limestone and chert fragments, which continue as far as Crump post-office (21 N., 33 W., section 21), over 200 feet above Sulphur Springs. From Crump the road running west to South West City, Missouri, crosses a plateau region underlain by the Boone chert. From Crump to Beaty* post-office, on the headwaters of Honey Creek, the descent is nearly 100 feet. The valley of the creek from Beaty to the Missouri line is not of sufficient depth to cut through the chert formation.

Between Nebo and Maysville.—Nebo lies in a valley somewhat below the adjacent plain, approximately at the level of Bentonville. The Nebo-Maysville road ascends to the plain in 20 N., 33 W., section 12, on which it runs for several miles, crossing an occasional ravine with chert-covered slopes. The crossing of Heater Spring Branch, in section 9 (20 N., 33 W.), is estimated to be about 50 feet below the Bentonville level, and 70 feet below the forks of the roads in section 11. In 20 N., 34 W., section 12, a descent is made to Beatie Prairie. The swampy area between sections 12 and 13 is about 90 feet below the Bentonville level.

Maysville, the old site,† which is situated on a tributary of Spavinaw Creek, on the Arkansas-Cherokee line, in 20 N., 34 W., section 21, the northeast quarter, is approximately 125 feet below Bentonville.

The Siloam Springs region.—The larger part of the town of Siloam City or Springs lies in 17 N., 33 W., section 6, the north half. To the north and east are the level stretches of Lindsley's Prairie. In 18 N., 33 W., section 31, half a mile north of the town, the sandstone which overlies the Boone chert occurs 30 feet above the springs. In section 30 and in 18 N., 34 W., section 25, the Fayetteville shale borders the sandstone

*When the name for the post-office was sent to Washington it was misspelled, hence the post-office is known as "*Beaty*," while the prairie is known as "*Beatie Prairie*."

†The "new town," on the line a quarter of a mile south of Maysville, is known as Rome City.

area 45 to 50 feet above the same level. The Box Spring near Hico post-office* is 50 feet, and Lindsley's Prairie, as encountered on the road to Springtown, 70 feet above Siloam Springs. Lindsley's Prairie is so even that over a distance of three miles the variation in level is probably less than 10 feet.

The road from Siloam Springs to Fisher's Ford traverses first the prairie region and then the flint ridges bordering the Illinois valley. In 17 N., 33 W., section 17, near the half-mile line east and west, the altitude is 130 feet above the springs at Siloam, while the descent from this point to the ford is 260 feet.

Upper and Lower Round Top.—In the vicinity of Robinson (17 N., 32 W., section 11, the northeast quarter) there are two isolated elevations known respectively as Upper and Lower Round Top. The former probably lies in the south half of section 10 and the latter about a mile south of it. Upper Round Top has an altitude of 400 feet above the Illinois River. It is crowned with the Batesville sandstone, and, at a lower level, encircled by the Fayetteville shale. From the southern end of its summit an excellent view may be had of the region lying to the south-southwest in Washington county, which may be compared with the profile of East, Kessler, and Rief Mountains given in the Washington county report.†

LIST OF RAILWAY ELEVATIONS IN BENTON AND WASHINGTON COUNTIES.

St. Louis and San Francisco Railway.‡

Location.	*Feet above tide.*	*Location.*	*Feet above tide.*
State line (Missouri-Arkansas)	1558	Highest point between state line and Garfield	1638
Garfield	1519	Rogers	1385
Little Sugar Creek	1361	Bentonville	1302
Lowell	1346	Clear Creek	1174
Springdale	1325	Greenland	1250
Fayetteville	1340	Woolsey's	1377
West Fork	1340	Winslow (Summit)	1735
Brentwood	1484		
Porter, Sebastian county	1092		

*The old settlement, now a suburb of Siloam City.

†Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV, p. 14.

‡The elevations on the St. Louis and San Francisco Railway are the spirit level elevations checked on the bench-mark of the Coast Survey at Van Buren, Arkansas.

*Railway survey in the western part of Benton county.**

Location.	*Feet above tide.*	*Location.*	*Feet above tide.*
Sulphur Springs	905	Divide between the Elk River system and the Spavinaw	1242
Spavinaw Creek	1012	Divide between Spavinaw and Flint Creeks	1395
Decatur	1220	Robinson	1016
Springtown	1210		
Osage Creek, south of Springtown	990		

*The railway levels in the western part of the county are furnished by Mr. S. R. Patterson, Chief Engineer of the Kansas City, Fort Smith and Southern Railway. They are on the line of a prospective railway ; it is probable that the city directrix of St. Louis is the bench-mark to which these elevations are referred. In this case each of the elevations given should be decreased by 13.6 feet.

CHAPTER II.

HYDROGRAPHY.

DRAINAGE.

Benton county is drained primarily by two river systems, White River draining the portion east of the St. Louis and San Francisco Railway, and Arkansas River the remainder. While the former river flows for many miles through the county, the drainage of the latter is affected through numerous tributaries, viz.: Illinois River, including Flint Creek, Spavinaw or Walnut Creek, a tributary of Neosho or Grand River, and Honey, Butler, and South or Little Sugar Creeks, flowing into Elk River, which in turn is a tributary of Neosho River, with which it unites in the northeast corner of Indian Territory.

*Illinois River drainage.**—The Illinois River enters Benton county in 17 N., 32 W., section 14. After flowing north for two miles it makes an abrupt turn to the west; keeping a general almost due west course for five miles it turns to the southwest and flows diagonally across 17 N., 33 W., leaving the county in the southwest corner of the township, which is also the corner of the county.

Tributaries of Illinois River.—The most important tributary of the Illinois River in Benton county is Osage Creek, which unites with it in 17 N., 32 W., section 4, the southwest quarter. This stream has its origin in the confluence of Big and Little Osage Creeks, which drain the area south and southwest of Bentonville. It is also materially increased by the waters of Wild Cat and Brush Creeks from the northern part of Washington county. Little Osage Creek has its origin in Mitchell's Branch, which flows from the Osage Prairie region southwest

*For an account of the Illinois River before it enters Benton county the reader is referred to the Report on Washington County, Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV, p. 18.

of Bentonville. It has a general south course to its confluence with Big Osage Creek. Big Osage Creek has its source in Osage Spring, four miles south of Bentonville, and has a general course west of south to the point of union with Little Osage Creek. Its principal tributary is Spring Creek. Osage Creek, from the confluence of Big and Little Osage, flows south of west to its junction with the Illinois River.

Chamber's Spring Branch, which empties into the Illinois River in 17 N., 32 W., section 7, is interesting on account of the exposures of Eureka shale near its mouth.

Flint Creek, named from the masses of flint (chert) debris along its course, rises northeast of Springtown, and has a general west-southwest course to near the Indian Territory line, where it is joined by Little Flint Creek, which drains the region south of Bloomfield.

Grand or Neosho drainage.—Spavinaw or Walnut Creek heads southwest of Dickson in 20 N., 32 W., and flows in a south of west course into Indian Territory. In places the creek is bordered by high bluffs of the Boone chert, one of the most prominent being the "Big Bluff of the Spavinaw," on the north side of the creek near the state line, where nearly 200 feet of interstratified limestone and chert are exposed. Lower bluffs are of common occurrence. The stream frequently "sinks" in the chert gravel for a distance, reappearing as a large creek with water of crystal clearness.

Of the tributaries of Spavinaw Creek mention may be made of Little Spavinaw, Dry Fork, and Coon Hollow Creeks. The region about Maysville on the state line is also drained by a creek uniting with Spavinaw Creek in Indian Territory.

Honey Creek, which rises southeast of Beaty post-office, drains the extreme northwestern corner of the county. Its general course is northwest.

Butler Creek rises southeast of Sulphur Springs in 21 N., 33 W. From its headwaters to its union with Seiler's Branch in the north half of section 25 it flows north, but from this point its course is northwest into Missouri, where it again bears to the north for three miles or more before emptying into Elk River.

The valley of Butler Creek is deep and well marked, as the stream has cut not only through the Boone chert of the Benton plateau, but down through the Eureka shale to the underlying Silurian magnesian limestones and quartzose sandstones. Exposures of the latter occur on the right bank of the creek along the line of the Kansas City, Fort Scott and Southern Railway. The depth of the valley and the outcrop of several kinds of rock has, of course, a marked effect upon the topography of this region. The tributaries of Butler's Creek are Seiler's Branch, Horse Creek, and West Fork.

South Sugar or Little Sugar Creek, also a tributary of Elk River, drains a large area west, northwest, north, and northeast of Bentonville. Its headwaters are in the region enclosed by Blansett, Rich, Humphrey, and Ratcliff Mountains in the northwest part of 20 N., 28 W. It has a general west course for 15 miles and thence its flow is north-northwest to the Missouri border. Its narrow valley is bounded at frequent intervals by precipitous limestone bluffs. Its tributaries are Dunlop's Branch, Jackson's Creek, Otter Creek, and Cash Hollow.

The headwaters of Big Sugar Creek are the numerous small branches flowing from the western half of 21 N., 28 W. The water-shed between them and the White River system is approximately indicated by the line of the railway. From the region about Garfield their general course is northwest; from the region west and north of the Devil's Eyebrow more to the west.

White River drainage.—The course of White River in Benton county is very tortuous. It flows through a narrow, winding valley bordered by precipitous slopes. In most instances an abrupt, occasionally overhanging, bluff occurs on the outside of the curves, and a narrow strip of alluvium bordered by a less precipitous slope on the inside of the curve. The general course of the river through the county is north of northeast; for the first ten miles the general course is north, then east for eight miles and north for over five miles to where it finally leaves the county. Although the distance in a straight line between the points where the river first enters and finally

leaves the county is about seventeen miles, the distance following the river would be four or five times that far, so winding is it. The river first enters the county in 18 N., 29 W., section 24, on the south side, and winds across sections 24 and 13, then flowing across the corner of Washington county re-enters Benton county in 18 N., 28 W., section 7. On the east side of section 24 White River approaches so close to War Eagle Creek that a person standing on the divide sees both streams within a few hundred yards of him, yet it is four miles to the confluence of the two streams by White River and nearly half that far by War Eagle Creek. One of the sharpest loops on the river is that at the mouth of Silver Spring Creek in the southeast part of 19 N., 29 W., where, after a sweep of nearly three miles, the stream returns within 200 yards of itself. On the north side of this graceful bend is a bold precipice of Boone chert, known as Devil's Head Bluff, from the top of which one looks down into the low area inside of the curve as into a pit surrounded on all sides by rugged hills. A somewhat similar but shorter curve occurs in the southwest part of 20 N., 27 W. As may be seen by the map there are other longer and more complex curves, such as those along township line 19 N., between Prairie and Big Clifty Creeks.

Tributaries.—The principal tributaries of White River in Benton county are War Eagle and Little Clifty Creeks on the east side; Silver Springs, Prairie, Ventry, Ford, Indian, and Spider Creeks on the west side. Other smaller tributaries are Rocky Branch, Esculapia Hollow, Pulham Branch, and Fish Trap Hollow.

The course of War Eagle Creek is almost wholly in Washington and Madison counties. It makes a long sharp loop to the north in the southeast part of Benton county. It has a course of seven or eight miles in the county, but leaves it less than two miles from the point where it entered. It joins White River in Washington county near the Benton county line. The part of the War Eagle Creek valley that lies in Benton county is comparatively narrow and bordered by steep rocky

slopes. The most prominent bluff is the one just north of War Eagle Mills.

SPRINGS.

The springs of Benton county are noted for their size and purity. With the exception of those at Sulphur Springs, they flow from the Boone chert, in almost every instance. About some of the finest springs, towns have been built, and attempts have been made to build them about others. The reputation of Eureka Springs, in Carroll county, as a health resort, has undoubtedly encouraged the building of these towns for similar purposes.

Siloam Springs.—In Siloam City, better known as Siloam Springs, and its vicinity there are the following springs:

I. Three quarters of a mile northeast of Hico, a suburb, in 18 N., 33 W., near the centre of section 32, is a large spring, known as Box Spring, which is the source of Sager's Creek.

II. At Hico, on the left bank of Sager's Creek, and near the township line, several springs known as the "Seven Sisters," have been walled in.

III. At Siloam City, in 17 N., 33 W., section 6, the southwest quarter of the northeast quarter, two small but excellent springs, known as the Twin Springs, issue from the limestone on the left bank of the creek.

IV. Farther down the stream, in the northeast quarter of the northwest quarter of the same section, is the "Old Mayfield Spring," now known as the "Siloam Springs," the most noted of the springs in this locality. This spring is also on the left bank of Sager's Creek, where it flows from a small cave in the chert and limestone. The mouth of the cave has been neatly walled up, so that the water may be delivered through three conduits. The following is an analysis of the water of this spring, made by the Geological Survey of Arkansas, Dr. A. E. Menke, analyst:

Analysis of the water of Siloam Spring.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.81	9.99
Chloride of soda ($NaCl$)	.68	8.38
Carbonate of lime ($CaCO_3$)	5.17	63.75
Carbonate of iron ($FeCO_3$)	.02	.24
Sulphate of soda (Na_2SO_4)	1.43	17.64
Total	8.11	100.00

Found.

Silica (SiO_2)	.81	9.97
Sodium (Na)	.73	8.99
Lime (CaO)	2.90	35.71
Iron (Fe)	.01	.12
Sulphuric acid (SO_4)	.97	11.94
Carbonic acid (CO_3)	2.29	28.20
Chlorine (Cl)	.41	5.07
Total	8.12	100.00

Water collected by A. E. Menke.

Temperature of air, 41° F.; of water, 60.8° F.

Total solid material in solution, 7.41 grains per U. S. gallon.

It is estimated that fully one half of the town of Siloam Springs derives its water supply from this and the Twin springs.

V. Farther down the creek and in its bed is a chalybeate spring, from which there is a good flow.

VI. There issues from the left bank of the creek another spring, known as the Spout spring, the water of which is said to be more readily affected by rainfall than those mentioned above.

The big spring at Springtown.—The big spring at Springtown is the exit of an underground creek, flowing with a strong current from beneath a bed of limestone. The limestone is exposed for a considerable distance below the spring and in places is several feet thick. Just above the outflow is a sinkhole in which the stream is visible. The location of the spring is in 18 N., 32 W., section 5, the southwest corner. This spring

is one of the principal sources of Flint Creek, and gave the name to the village of Springtown.

Springs at Cherokee City.—There are several springs at Cherokee City, all flowing from the chert and limestone. From one of the best, on the south side of the town, pure water is forced by a hydraulic ram into the business portion of the village.

Eldorado Springs.—Pactolus post-office.—Some years ago the water at Pactolus acquired quite a reputation for its medicinal properties, and an attempt was made to build up a town. This failed, and now the spring is surrounded by only a few dilapidated buildings. Its location is in 20 N., 33 W., section 31, the southeast quarter.

Schooler's spring.—In 20 N., 34 W., section 24, the northwest quarter, is a remarkable spring. Its waters gush up with such violence that the surface of the pool is in several places elevated, as if in a state of ebullition. An examination of the region about this spring shows that it is near a fault, the Boone chert abutting in the immediate neighborhood against a sandstone escarpment. While large springs along the line of a fault are not infrequent, this is the only well marked instance in Benton county, a region noted for the abundance of its springs.

Springs at the town of Sulphur Springs.—There is a thriving town about the springs on Butler Creek, in 21 N., 33 W., section 23, the southeast quarter of the southeast quarter. The several springs have been neatly boxed in and are surrounded by ample grounds. The waters contain sulphuretted hydrogen in varying proportions, and have their origin in the magnesian limestones of Silurian age which underlie the valley at this point. The water is much used for drinking purposes and for bathing. The popularity of these springs as a health resort is shown by the constantly increasing number of visitors.

The following is an analysis of the water from one of these springs, made by the Geological Survey, Dr. A. E. Menke, analyst:

Analysis of the water of Sulphur Spring.

Hypothetical combination.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.72	3.17
Chloride of soda ($NaCl$)	9.34	41.13
Carbonate of magnesia ($MgCO_3$)	4.48	19.73
Carbonate of lime ($CaCO_3$)	6.51	28.66
Carbonate of iron ($FeCO_3$)	.12	.53
Sulphate of soda (Na_2SO_4)	1.33	5.86
Alumina (Al_2O_3)	.21	.92
Total	22.71	100.00

Found.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.72	3.17
Sodium (Na)	4.10	18.05
Magnesium (Mg)	1.28	5.64
Lime (CaO)	3.64	16.03
Iron (Fe)	.06	.27
Alumina (Al_2O_3)	.22	.97
Sulphuric acid (SO_4)	.90	3.96
Carbonic acid (SO_3)	6.13	26.99
Chlorine (Cl)	5.66	24.92
Total	22.71	100.90

Sample collected by A. E. Menke, November 16, 1891.

Temperature of air, 28.4° F.; temperature of water, 61.7° F.

Sulphuretted hydrogen gas in solution, 0.0002 grains per United States gallon.

Chalybeate spring.—On the West Fork of Butler Creek, just below the new stone dam in 21 N., 33 W., probably near the line dividing sections 21 and 22, is a chalybeate spring, now walled in. It first appeared on the bank of the creek, but in blasting the Silurian limestone it ceased to flow, and finally broke out at a lower level in the bed of the creek.

Anderson's spring.—In 19 N., 31 W., near the line between sections 20 and 29, just off the Bentonville-Siloam Springs road, is a magnificent spring, from which flows a stream ten to twelve feet wide and four to six inches deep, forming one of the sources of Little Osage Creek. It flows from the Boone chert.

Bluff spring.—In 19 N., 31 W., section 34, the northeast

quarter, a stream of water issues from the bluff bordering Osage Creek. It flows from beneath a limestone stratum over chert, forming a miniature cascade ten feet high.

Osage spring.—The Osage spring is in 19 N., 30 W., section 16, the southeast quarter of the southwest quarter. It is usually regarded as the source of Big Osage Creek. Several underground streams, evidently from the same source, burst forth from a flinty bank, forming a stream of clear, cold water four feet wide and six inches deep, with a very rapid current.

Cave spring in 18 N., 31 W., section 1.—Near the center of this section a large volume of water issues from two cavernous openings beneath a limestone bluff 40 feet in height. It was once used to run a mill.

Spring near the Missouri line.—In the valley of Little Sugar Creek, a quarter of a mile south of the Missouri line on the Pinville–Bentonville road, a fine spring flows from beneath a limestone bluff, near the level of the Eureka shale.

Cave spring in 20 N., 30 W., section 1.—A large spring issuing from a cavern and known as Cave spring, is reported in 20 N., 30 W., section 1, near the center of the north half, about four and a half miles from Bentonville.

Bentonville springs.—Of the springs at Bentonville mention may be made of the following: Crystal spring in the northern part of the town (20 N., 30 W., section 29, the southwest quarter of the northwest quarter); the springs in the park, less than half a mile from the public square in a direction a little east of north; and a spring at the mill a few blocks east of the square.

Morrison's spring.—In the valley of Otter Creek a large spring flows from beneath a limestone ledge in the chert formation. It is about a quarter of a mile north of Pea Ridge post-office in 21 N., 30 W., section 35, the southeast quarter.

Diamond spring.—The town of Rogers receives its water supply from Diamond spring, situated in 19 N., 29 W., section 7. The clear, sparkling water issues from the Boone chert in a little valley less than one mile from the town. The water is forced by a steam pump into the stand-pipe in the town.

Several fish-ponds have been constructed along the stream below the spring.

The following analysis of the water has been made by the Geological Survey of Arkansas, Dr. Albert E. Menke, analyst:

Analysis of the water of Diamond spring, near Rogers.

Hypothetical combination.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.520	3.80
Chloride of soda ($NaCl$)	.010	.07
Carbonate of lime ($CaCO_3$)	13.120	95.96
Carbonate of iron ($FeCO_3$)	.020	.15
Sulphate of magnesia ($MgSO_4$)	.003	.02
Total	13.673	100.00

Found.

Silica (SiO_2)	.520	3.80
Sodium (Na)	.005	.04
Magnesium (Mg)	.006	.04
Calcium (Ca)	5.250	38.38
Iron (Fe)	.010	.07
Sulphuric acid (SO_4)	.002	.02
Carbonic acid (CO_3)	7.880	57.61
Chlorine (Cl)	.006	.04
Total	13.679	100.00

Water collected by assistant T. C. Hopkins.

Temperature of air, 29.3° F.; of water, 57.2° F.

Electric springs.—The most noted medicinal springs in the eastern part of Benton county are those in 19 N., 29 W., section 8, a little northeast of Rogers. Here there are a dozen springs within a single quarter section, of which the Electric springs are the most noted. This name is given to three small springs, or perhaps one with three openings. The following is an analysis of the water, made by Messrs. Potter and Riggs of St. Louis, Missouri, in 1881, a copy of which has been kindly furnished by Professor W. B. Potter, of Washington University, St. Louis:

Analysis of the water of Electric springs, near Rogers.

Constituents.	Grains per U. S. gallon.
Silica (SiO_2)	.552
Iron and aluminum (Fe, Al)	.025
Chloride of soda (NaCl)	.174
Chloride of potash (KCl)	.008
Sulphate of potash (K_2SO_4)	.397
Sulphate of lime ($CaSO_4$)	.328
Bi-carbonate of lime ($CaCO_3$, CO_2)	20.488
Bi-carbonate of magnesia ($MgCO_3$, CO_2)	.488
Total	22.460

Temperature of the air, 90° F.; of the water, 55° F.

"The water belongs to the calcic or lime class of waters with small quantities of the alkalies. There is no free gas in the water and the mineral matter is not sufficient to give a taste to it. In general character it is not unlike the Bethesda water of Waukesha, Missouri, and the Yellow Springs water of Ohio." (Potter and Riggs.)

These springs are a little over 200 feet lower than Rogers, and about a mile and a quarter from the town. There are now (1891) three hotels at the springs and another on the hill near by. A line for a street railway has been surveyed from the town to the springs, and it is hoped that the road will soon be in operation.

Of the other springs in this vicinity mention may be made of "mossy spring" and "bath rock spring," the latter so named from a natural cavity in the rock shaped much like a bath tub. There are also two springs which are slightly chalybeate. The remainder are clear, odorless, and tasteless. All of these springs flow from the Boone chert and its accompanying limestone.

Esculapia springs.—In 19 N., 29 W., section 16, the south-east quarter, are two small springs noted for their medicinal properties. They are known as Esculapia springs, and flow from the chert formation at the bottom of a small ravine about 200 yards north of the wagon road from Rogers to Van Winkle's mill. A few years ago several houses were built near the springs, which for a time, were the resort of a number of

invalids, but the property was in litigation, and the houses have been abandoned. The springs are now rarely visited. The following is an analysis of the water from the larger spring made by the Geological Survey, Dr. Albert E. Menke, analyst:

Analysis of the water of Esculapia springs.

Hypothetical combination.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Chloride of soda ($NaCl$)	.84	6.80
Chloride of potash (KCl)	.23	1.86
Carbonate of soda (Na_2CO_3)	6.29	50.93
Carbonate of lime ($CaCO_3$)	3.49	28.[illegible]6
Sulphate of magnesia ($MgSO_4$)	.08	.65
Sulphate of iron ($FeSO_4$)	1.42	11.50
Total	12.35	100.00

Found.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.75	5.72
Sodium (Na)	3.06	23.34
Potassium (K)	.11	.84
Magnesium (Mg)	.01	.08
Calcium (Ca)	1.40	10.68
Iron (Fe)	.40	3.05
Sulphuric acid (SO_4)	1.09	8.32
Carbonic acid (CO_3)	5.66	43.17
Chlorine (Cl)	.63	4.80
Total	13.11	100.00

Water collected by assistant T. C. Hopkins.

Temperature of air, 27.04° F.; of water, 52.7° F.

Total solid matter in solution, 15.00 grains per U. S. gallon.

The Silver spring.—Silver spring, near the center of section 28 (19 N., 29 W.), is one of the largest and most beautiful springs in the county. It emerges from the base of a small bluff of the Boone chert in a crystal stream two or three feet deep and from six to ten feet across. The water is used to run a flouring mill, a distillery, and a sawmill situated a short distance below the spring.

Frisco spring.—Frisco spring is in 19 N., 29 W., section 33, the southwest quarter. It has considerable reputation locally

for its healing properties. It issues from the head of a ravine 65 feet below the top of the hill and 340 feet above White River. The analysis of the water of the spring, given below, is by the Geological Survey of Arkansas, Dr. Albert E. Menke, analyst:

Analysis of the water from Frisco spring.

Hypothetical combination.

Constituents.	Grains per U. S. gallon.	Per cent. of total solids.
Silica (SiO_2)	.41	3.49
Chloride of soda ($NaCl$)	.86	7.52
Chloride of potash (KCl)	.14	1.22
Carbonate of lime ($CaCO_3$)	8.77	76.66
Carbonate of iron ($FeCO_3$)	.84	7.34
Sulphate of magnesia ($MgSO_4$)	.42	3.67
Total	11.44	100.00

Found.

Silica (SiO_2)	.41	3.58
Sodium (Na)	.34	2.29
Potassium (K)	.07	.61
Magnesium (Mg)	.08	.70
Calcium (Ca)	3.51	30.65
Iron (Fe)	.41	3.58
Sulphuric acid (SO_4)	.34	2.97
Carbonic acid (CO_3)	5.70	49.78
Chlorine (Cl)	.59	5.15
Total	11.45	100.00

Water collected by assistant T. C. Hopkins, March 18, 1892.
Temperature of air, 38.3° F.; of water, 53.6° F.

Cross Hollow spring.—There is a large spring at Cross Hollow, section 31 (19 N., 29 W.), the northwest quarter, flowing from the base of a limestone bluff belonging to the Boone chert formation. Its basin is five or six feet across and eighteen inches deep. The stream flowing from the spring is probably five feet wide and six inches deep.

WELLS.

From the foregoing it will be seen that Benton county is well watered. The numerous springs afford, as a rule, most

excellent water for drinking and household purposes, while that obtained from wells is as good as is usually secured from such sources. In some instances the use of well water has been the cause of ill health. In most cases the mischief could probably have been avoided by the exercise of proper precaution. The site of a well should be carefully selected, and every effort made to reduce to a minimum contamination by surface drainage. Shallow wells should be avoided. Occasionally families are found using water from wells so shallow as to be little better than wet weather holes. This is dangerous. A well that fills up with every rain is certainly liable to contamination. The various strata through which water percolates act as filters, and it is reasonable to believe that, other things being equal, the water which has been the least filtered will contain the most impurities. Again, the location of wells in towns is a matter of serious importance. The liability to contamination of the water supply in a town, it must be borne in mind, is much greater than in the country, for sooner or later the soil becomes saturated with impurities of various kinds. For this reason there is much greater safety in a system of waterworks, supplied from a proper source, than in using well water. There are now many wells in Bentonville which are not in a good sanitary condition. That sickness from this cause has not been more widespread is due to the general healthfulness of the country rather than to the care of the well owners. It should be remembered though, that as the town grows older the chances for corruption increase. It is especially advised that all sources of impurity, such as privies, barns, cowpens, and other necessary outbuildings, as well as stableyards, be as far removed as possible from the well. But in many instances it is doubtful if this precaution will suffice. Those who use cisterns must not be unmindful of the fact that even rain-water may become a menace to health if the cistern be allowed to become filthy.

In a few localities it is difficult to obtain water even in wells fifty or sixty feet deep. Such is the case, for instance, along the road traversing the northern tier of sections in 19 N., 33 W.

CHAPTER IV.

The Rocks of Benton County.

The rocks of Benton county are included in three systems, viz.: the Silurian, the Devonian (?), and the Carboniferous. They are all of sedimentary origin, and are made up of cherts, limestones, sandstones, and shales. Of the limestones there are two general classes: those containing magnesia, known as magnesian limestones, dolomites, or dolomitic limestones; and those composed almost entirely of carbonate of lime. The chert (flint) occurs as nodules or interstratified bands in some of the limestones.

The sandstones also vary somewhat lithologically; one kind, known as saccharoidal sandstone, is so pure, clear, and white that a fresh sample of it resembles loaf sugar; under weathering influences it becomes loose in texture, and resembles granulated sugar. Ordinarily the sandstones are cemented with a ferruginous cement, and are therefore of a reddish or yellowish brown color. Weathering sometimes brings out on some of the sandstones remarkable concentric iron-stained bands.

The shales of the various ages are usually dark or black, with now and then brownish stains produced by the presence of iron.

The various sediments contain in themselves evidence of the conditions under which they were deposited. The limestones must have been formed in a clear sea, free from mud, and in which there was a profusion of animal life, especially of the lime-secreting forms; while sandstones are shore deposits and shales are mud deposits.

The various horizons represented in Benton county are given in the following table in their natural order.

The formations of Benton county.

		Formation.	Thickness in feet.
Lower Carboniferous	VII.	Batesville sandstone	200
	VI.	Fayetteville shale	25
	V.	Wyman sandstone	10
	IV.	Boone chert	250
Devonian (?)	III.	Eureka shale	50
Silurian	II.	Saccharoidal sandstone	70
	I.	Magnesian limestone	250

SILURIAN ROCKS.

The rocks of Silurian age exposed in Benton county have not been correlated with formations outside of the state, nor has enough detailed work been done on them to justify even a provisional classification; they are therefore distinguished by their lithologic characters. They consist of limestones, sandstones, and chert.

Magnesian limestones.—In Benton county the bulk of the Silurian rocks below the saccharoidal sandstone is composed of limestones containing variable quantities of magnesia. Some are true dolomites* while others contain an excess of lime and many of them are highly siliceous. The siliceous magnesian limestones often have a dark leaden gray color, while the purer ones are gray and buff colored. Both kinds occur in regular, more or less evenly bedded layers from two inches to two feet or more in thickness. They are very durable, outcropping in prominent angular ledges. Sometimes layers offering greater resistance to the erosive agents than those above and below, project in continuous ledges that may be followed with the eye for several miles along some of the thinly wooded hillsides. The purer of the magnesian limestones have comparatively smooth, even surfaces on their weathered exposures. At other places the silica tends to segregate; and as the more siliceous parts of the bed are more durable than the other parts the rock weathers with an uneven, pitted surface.

The upper limit of the magnesian limestones in the White River valley is 19 N., 29 W., section 12, possibly extending into 19 N., 28 W., section 7. South of this no Silurian lime-

*Pure dolomite consists of 54.35 per cent. carbonate of lime and 45.65 per cent. carbonate of magnesia.

stones were observed, but to the north nearly all of the Silurian area shown on the map is of the magnesian limestones.

Exposures.—Fine exposures of the magnesian limestones occur at the following localities: On Indian and Spider Creeks; in 20 N., 28 W., on the Rogers-Eureka Springs road in the southwest part of the township; on both sides of the Rogers-Eureka Springs road in the southeast part of the township; on Ford and Cedar Creeks; in Fish Trap Hollow; in 19 N., 28 W., in the northwest part of the township, on the road to Van Winkle's mill, through sections 5 and 8; in the northeast part of the same township in the valleys of Rocky Branch and Little Clifty Creek; in 21 N., 33 W., along Butler Creek and its tributaries.

Details.—The entire thickness of the Silurian rocks at the mouth of Indian and Spider Creeks is a little over 300 feet, of which over 250 feet are magnesian limestone. Their thickness as exposed in the bluff below Jennings' Ford, in the southeast corner of 20 N., 28 W., is at least 150 feet, of which 100 feet or more are of the magnesian limestone division.

At Caverna, McDonald county, Missouri, a short distance north of the state line, in 21 N., 31 W., section 34, near the center of the section, the valley of Little Sugar Creek has been eroded to a sufficient depth to expose the Silurian rocks. Just below the mill-dam and immediately beneath the Eureka shale magnesian limestone outcrops.

In 21 N., 33 W., Butler Creek has cut its valley through the Boone chert and the Eureka shale into the underlying Silurian rocks. Under a trestle just north of the depot at Sulphur Springs two feet of compact magnesian limestone are exposed. There is another and thicker exposure a little further north at the northern end of a second trestle. Nearly a mile from the depot, down Butler Creek, six feet of the same kind of rock are exposed on the right side of the valley, near the railway track. It is interstratified with a layer of chert (flint) nodules, and is overlain by a thick bed of limestone. At this exposure is a slight syncline, and a little further down the valley an anticline; at the exposure at the anticline, which is about a quar-

ter of a mile south of the state line, there is a bed of quartzose sandstone six feet thick. Above the sandstone are arenaceous limestones, some of which have weathered brown, but on a fresh surface they are of a light cream color. The quartzose layers occur again on the edge of the west fork of Butler Creek, at the Baptist Church, near the center of section 15, where they are 75 feet below the level of the railway at the Sulphur Springs depot.

Magnesian limestones are well shown in the valley of the west fork of Butler Creek; they have also been quarried by the stone dam at the base of Round Top, near the line between sections 21 and 22. South of Sulphur Springs they also appear beneath the Eureka shale along Horse Creek.

Silurian chert.—The chert in the Silurian rocks differs in appearance from the Boone chert of the Carboniferous so much that where any quantity of either exists there is no difficulty in deciding to which class it belongs; but, in places, the weathered fragments on the slopes, stained with the surface waters, so closely resemble each other that it is frequently impossible to decide from single fragments whether they are from the Boone chert or from some of the Silurian chert beds.

The chert of the Silurian rocks is usually harder and more compact than that of the Boone chert formation. It also varies in color, dark gray predominating, with concentric bands of a lighter shade in the nodules. In many places it approaches agate in texture, being then properly an agatized chert. It can be drilled or dressed only with great difficulty. Many pieces are so beautifully banded, and have such fine texture, that if properly stained and polished they would make attractive ornaments.

It occurs mostly as irregular concretionary nodules and masses in the dolomites and siliceous limestones, the nodules varying from a few inches to a foot or more in diameter. In some places the chert occurs as irregular layers interstratified with the siliceous limestones. As a rule the more chert in the limestone at any place, the more silica is diffused through it, while the comparatively pure magnesian limestone is almost

entirely free from the chert concretions. The chert occurs in varying quantities throughout the entire Silurian area shown on the accompanying map of Benton county, excepting in that part of it south of 19 N., 29 W., section 12, where saccharoidal sandstone is the only Silurian rock exposed.

*The saccharoidal sandstone.**—The uppermost bed of Silurian age in the White River region is a white, saccharoidal sandstone, which is commonly massive, but occasionally laminated in its upper part and brecciated at the bottom. It varies greatly in thickness, in some places being almost, if not entirely, wanting, while in others it is not less than 60 or 70 feet thick. Its greatest thickness is in the southern part of the area, the bed thinning out irregularly toward the north.

Exposures.—The following is a list of localities in Benton county where the saccharoidal sandstone occurs: in 19 N., 27 W., on the east fork of Little Clifty Creek in section 17; in 20 N., 27 W., section 5; in 18 N., 28 W., sections 7 and 18; in 19 N., 28 W., in the northeast part, south of White River, and on the west fork of Little Clifty Creek, in sections 14, 22, and 23; in 20 N., 28 W., on Cedar and Ford Creeks, in the bluff down-stream from Jennings' Ford; in 18 N., 29 W., in section 3, on the south side of White River, in sections 12, 13, and 24; in 19 N., 29 W., at the ferry in section 25, at the ford in section 34; in 20 N., 29 W., section 35, the southeast quarter, on the east side of the Rogers-Eureka Springs road.

Local details.—In the southern part of 19 N., 28 and 29 W., and in 18 N., 28 and 29 W., the saccharoidal sandstone is exposed in a series of gentle anticlines along the banks of White River. In the southernmost one of these anticlines, that in 18 N., 28 W., sections 7 and 18, and in 18 N., 29 W., sections 12, 13, and 24, is the largest exposure of the sandstone, both in area and thickness.

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*The saccharoidal sandstone here described appears to be one of several very similar sandstones in the Silurian. The others occur at a greater depth—that is, below some of the limestones. For example, a saccharoidal sandstone outcrops on the road down Butler Creek a short distance north of the Arkansas line, but it is 50 or 60 feet below the Eureka shale.—F. W. Simonds.

The finest vertical exposure is in the bluff on the west bank of White River, southwest of Mr. Ellis' farm, 18 N., 29 W., section 13, where the rock is exposed close to the water's edge in a massive, perpendicular ledge sixty or seventy feet in thickness. The sandstone dips beneath the water level near the half-mile line on the west side of section 24, below which it again rises, attaining its maximum thickness in the south part of section 13. On the east side of the river there is a small exposure in the northwest quarter of section 24 (18 N., 29 W.), and in the southeast quarter of section 13, in the same township, a larger areal exposure which, being on the inside of the curve, is covered with river drift. At the confluence of White River and War Eagle Creek no saccharoidal sandstone is exposed, as it is beneath the water-level on the east side and concealed by alluvium on the west. However, a half mile from the river in 18 N., 28 W., section 18, the west side, and the southwest quarter of section 7, and in 18 N., 29 W., the south part of section 12, there is a large areal exposure, continuous with that in the bluff on the south side of section 13. In 18 N., 28 W., section 18, the west side, south of the wagon road, the outcrop of sandstone covers an irregular, nearly flat area of several acres which is entirely bare in some places, and in others covered with a thin soil.

The area in 18 N., 29 W., between the middle of the south side of section 12 and the ravine in the south half of section 3 was not traversed, but the topography indicates an outcrop of sandstone along the base of the river hills between these two points, though probably more or less concealed by the river deposit on the one side and the chert debris on the other. On the south side of the river in section 3 the sandstone outcrops in a low bluff along the water's edge, and in places it extends back from the river 100 yards or more in a low, irregular flat.

Between the south part of section 3 and the east part of section 12 (19 N., 29 W.), the saccharoidal sandstone does not outcrop at any great height above the river, while in some places it dips entirely beneath the water-level. A thickness of six to ten feet is exposed immediately above the ford in 19 N., 29 W., section 34, the southwest quarter. At the ferry in

section 25, the northeast quarter, a half mile south of Key post-office, a bed from ten to twenty feet thick is exposed.

Down White River from 19 N., 29 W., section 11, the Silurian rocks cover a much larger area than they do up-stream, but, owing to the thinning of the bed, the saccharoidal sandstone outcrop is not so marked. In a few places the marked local changes in the thickness of this bed suggest an unconformity between it and the underlying rocks, or at least that the sandstone was deposited on a very uneven surface. Such a sandstone prominence occurs in 20 N., 29 W., section 35, the southeast quarter, on the east side of the Rogers-Eureka Springs road, 300 yards north of the big spring. Other similar ones occur on the south side of White River in the northeast part of 19 N., 28 W.

On Ford and Cedar Creeks in 20 N., 28 W., the saccharoidal sandstone forms a layer from two to ten feet thick, but in many places it is entirely concealed. The thickest exposure at its northern limit is at the little water-mill in section 14, the southwest quarter, where it outcrops as a steep ledge in the bottom of the valley, forming a waterfall in the creek.

On the west fork of Little Clifty Creek in 19 N., 28 W., sections 22, 23, and the south part of 14, it outcrops in the bottom of the creek. The exposure nearest the head of the creek is crossed by the wagon road less than half a mile below Van Winkle's mill. In the east part of section 14 and in sections 13 and 12 (19 N., 28 W.) it occurs near the tops of the hills in occasional outcrops from three to ten feet thick. There are similar exposures on the east prong of Little Clifty Creek, the upper limit being at the fault in 19 N., 27 W., section 17, the southeast quarter. It outcrops in a massive ledge in 20 N., 27 W., section 5.

On Spider and Indian Creeks in 20 and 21 N., 27 and 28 W., an occasional boulder or thin ledge of the saccharoidal sandstone appears just underneath the black Eureka shale.

THE EUREKA SHALE (DEVONIAN ?).

Position and character.—The Eureka shale is the name given

by the State Geologist to a bed of black shale immediately below, or at the base of the Boone chert. As yet some uncertainty exists as to whether it belongs to the Devonian or to the Carboniferous system.*

It is a black, bituminous, argillaceous, and often very pyritiferous shale varying in thickness from five to fifty feet.

Exposures.—Outcrops of the Eureka shale are common along the valley of White River for almost its entire course through Benton county. The following localities may, however, be specially mentioned: in 19 N., 27 W., along the road from Big Clifty Creek to Rocky Branch, in section 6; in 20 N., 27 W., in section 7, on the road from Garfield to Eureka Springs, and in section 29; in 18 N., 28 W., along the banks of War Eagle Creek, in sections 3, 9, and 10; in 19 N., 28 W. section 1, and on Little Clifty Creek, below Van Winkle's mill, in section 22; in 20 N., 28 W., near the head of Ford Creek, in sections 14 and 23, at the head of Fish Trap Hollow, near Larue post-office, in section 25, on the road from Jennings' Ford to Poor Mountain, in section 26, and on the Rogers-Eureka Springs road, in section 28; in 18 N., 29 W., in the southern part of section 3, and in sections 13 and 24; in 19 N., 29 W., near the center of section 13, in sections 33 and 34, and on the Rogers-Van Winkle mill road in section 24, near Key post-office; in 20 N., 31 W., the northwest corner, in the valley of Little Sugar Creek; in 21 N., 31 W., along the valley of Little Sugar Creek; in 17 N., 32 W., near the mouth of Osage Creek, in section 4, on Chambers' Spring Branch, in section 7; in 21 N., 32 W., at Seiler's Spring in section 30, the northeast quarter; in 17 N., 33 W., the southwest part, along the Illinois River; in 19 N., 33 W., in the valley of the Dry Fork of Spavinaw Creek, northeast of Decatur; in 21 N., 33 W., along Butler Creek and its tributaries; near the state line it is over a hundred feet above the creek.

Local details.—One of the thickest outcrops of the Eureka shale is in 18 N., 29 W., section 13, on the west side of White

*Foot-note in the Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV., p. 26.

River, south of the Rogers-Pine Creek road. In many places even where it occurs in a bed many feet in thickness it is not exposed, owing to the fact that it decomposes quite rapidly, and to its position beneath the durable chert. The decomposed shale is often carried away by the surface waters, leaving the beds above it as overhanging cliffs of limestone and chert. These in time break down, concealing the shale under the talus. However, where the force of the water is sufficient to carry away this talus, as on the outside of curves along watercourses, the shale is exposed at the base of a perpendicular bluff. Good examples of this are the bluffs in 18 N., 29 W., sections 13 and 24; and 19 N., 29 W., sections 33 and 34. Larger areal exposures appear when the formation is at or near the top of a hill with but little overlying rock to conceal it. The most notable examples of this kind are in 20 N., 28 W., section 26, on the wagon road from Jennings' Ford to Poor Mountain; in 19 N., 28 W., section 1; and in 19 N., 27 W., section 6, on the wagon road from Big Clifty Creek to Rocky Branch, where the road follows the Eureka shale outcrop for more than a mile.

Among the many exposures in the eastern part of the county mention may be made of the following: in 19 N., 29 W., section 24, it appears on the wagon road from Rogers to the Van Winkle mill on the north side of the little branch 200 yards south of Key post-office; also near the center of section 13, west of the wagon road in the ravine leading from Ozark school-house.

In 20 N., 28 W., it is exposed in section 23, on the hill at the head of Fish Trap Hollow; in section 28, west of Ford Creek on the road from Rogers to Eureka Springs; and in section 25, on the same road, about three quarters of a mile northeast of Larue post-office.

It also appears in 18 N., 29 W., section 3, the south part, on the east side of the ravine; in sections 12 and 13, on the road from Rogers, to the mouth of War Eagle Creek. It appears in 18 N., 28 W., sections 3, 9, and 10, along the banks of War Eagle Creek.

West of the St. Louis and San Francisco Railway in the re-

gion drained by the tributaries of the Arkansas River, the Eureka shale is exposed in the valley of Little Sugar Creek two and a half or three miles from Bentonville. The creek at this point, 20 N., 31 W., section 12, the northeast quarter, is about 250 feet below Bentonville. The shale outcrops beneath the Boone chert above the road on the left bank, 25 or 30 feet above the water. The outcrops now continue along the creek as far as Caverna, McDonald county, Missouri.

The following localities occur along Little Sugar Creek: in 21 N., 31 W., probably in section 35, the shale on the left bank of the creek is in contact with the lowest beds of the Boone chert and limestone formation, which here forms a low bluff; a little farther down the stream, in section 26, the south half, the shale appears on the right bank of the stream; at Mr. Carrico's place, near the center of section 26 (21 N., 31 W.), the Eureka shale is cut in a well; it was noticed still farther down the creek, probably in section 22; on the state line it occurs in a well nine feet below the surface; near the mill at Caverna there is a good exposure, overlying the magnesian limestones. Based upon the elevation observed at Caverna, the thickness of the shale at the railway cut in section 22 is about 50 feet—probably its maximum thickness.

The next streams in Benton county, west of Little Sugar Creek, which cut through the Boone chert and expose the underlying rocks are Butler Creek and its tributaries. The Eureka shale is exposed on the road from Bentonville to Sulphur Springs (*via* Dickson post-office) in 21 N., 32 W., section 30, the northeast quarter, at Mr. Seiler's spring-house on the south side of the valley. It outcrops immediately beneath the chert and limestone, about 280 feet below Bentonville.

In 21 N., 33 W., section 24, the southeast quarter of the southwest quarter, at Mr. Lewis' place, eighteen feet of shale were cut in a well. Just north of Sulphur Springs the shale is exposed on the hillside 40 or 50 feet above the town, its fragments being scattered down the slope over an interval of about 40 feet. From examinations made elsewhere in this vicinity it appears that this shale has a thickness of from 30

to 35 feet. Just south of the town there are good exposures, especially along the old Chalk Valley or Nebo road, which passes up the right side of the valley of Horse Creek. In section 26 the magnesian limestones with their concentrically banded flint nodules appear below the shale, while above it are the limestones of the Boone chert. The thickness of the shale bed is here from 30 to 35 feet. It also outcrops in section 25, along the Sulphur Springs-Nebo road, and is reported on the Cary land in section 36.

Below (north of) Sulphur Springs, near the state line, the shale outcrop is fully 100 feet above the railway track, and above it is a heavy limestone bluff. Across the valley of Butler Creek and almost west of the last named locality, on the road to Crump post-office, probably in the east half of section 16 and the west half of section 15, the shale outcrops beneath a limestone ledge. The summit of Round Top, in section 22, the northwest quarter, is capped with the lower beds of limestone belonging to the Boone chert formation; the shale underlies this limestone.

It was expected that the Eureka shale and probably the underlying magnesian limestones would appear in the other valleys in the northwestern and western part of the county, but from Butler Creek to the valley of the Illinois River in the southwestern part of the county no outcrops have been found, excepting those on Spavinaw Creek and on the Dry Fork of the same. It has been reported as underlying the limestone bluff just above the ford of the "line road" in 19 N., 34 W., section 10, but an examination of the base of that cliff failed to show it. It may possibly be exposed at this point, however, at times of very low water. Farther up-stream in section 1, the northwest quarter, it does appear. The overlying limestone rises in a gentle undulation and overhangs the exposed shale, which has yielded more rapidly to eroding agencies. It occurs along the banks of the creek for half a mile.

Northeast of Decatur, in the valley of the Dry Fork of Spavinaw, half a mile above the crossing of the road to Nebo, the black shale again appears beneath the limestone bluff.

These are the only exposures noted in the region between Butler Creek and the Illinois River. In themselves they are insignificant, yet they serve to indicate the base of that very widespread and important formation, the Boone chert. Possibly there are other outcrops, but if they exist at all they must be small.

In 17 N., 32 W., section 4, the northwest portion, near the mouth of Osage Creek, large fragments of the black shale were found in the bed of the stream. A short distance up-stream the Eureka shale is exposed in the creek bank. The jointing at this locality is distinctly shown and the dip of the rocks seems to be southeast. Farther up the creek, in 18 N., 32 W., section 33, the west half, at the ford of the Springtown-Robinson road, the shale occurs in the right bank, and along the stream for a short distance above this point. Down-stream it is undoubtedly continuous with the exposure at the ford.

At Mark Schuck's spring in 17 N., 32 W., section 7, near Chambers' spring branch, there is an exposure of black shale three or four feet thick. Continuing down the Illinois River there are no more outcrops until about a quarter of a mile below Fisher's Ford, in 17 N., 33 W., near the line between sections 28 and 29, where in a ravine twelve to fifteen feet of typical shale appear just below the lowest layers of the Boone chert formation. There is another exposure at O'Brien's spring, in the southwest corner of Benton county, 200 yards above the 27th mile-post on the Arkansas-Cherokee line. This outcrop is believed to be a continuation of that below Fisher's Ford. The same difficulty exists here in tracing the shale outcrop as has been repeatedly noticed elsewhere, viz.: the complete covering of the shale with fragments from the overlying chert.

CHAPTER V.

ROCKS OF BENTON COUNTY—*Continued.*

THE BOONE CHERT AND LIMESTONE.

Distribution.—The Boone chert with its accompanying limestone is the most conspicuous formation in Benton county, having both a greater areal distribution and a greater thickness than any other formation. It forms the great plateau or peneplain north of the Boston Mountains, which in places is cut through to the Silurian rocks, while above it rise a few isolated, island-like masses, remnants of higher formations. These outliers of higher formations for the most part are in the northeastern portion of the county, and mainly in the region which is most deeply eroded. In the southwestern part of the county, southwest of Robinson, are other masses, which are outliers of the Wedington Mountains, of Washington county. There is another small area just north of Siloam Springs, in which higher formations appear, but with no marked topographic effect.

For convenience the entire formation is divided as follows:

I. Limestone above the chert proper.
II. Limestone and chert interstratified.
III. Limestone beneath the chert proper.

The limestone above the chert.—The limestone overlying the chert proper is not a heavy bed in Benton county, probably never exceeding forty feet in thickness, and generally being much less. Its exact thickness is difficult to determine, owing to the partings between it and the underlying chert, and also between it and the overlying sandstone, being in nearly all cases concealed by debris. It outcrops in rounded boulders or prominences through the soil around the border of the Batesville sandstone areas. It is strongly charged with bitumen, and gives off a fetid odor when struck with the hammer

When freshly broken it has a dark gray color, but when long exposed it changes to a light gray. Furthermore, it is coarsely crystalline, slightly fossiliferous, homogeneous in texture, very tenacious, has a conchoidal fracture, and rarely presents sharp edges on weathered exposures.

Unless concealed by debris it outcrops around the borders of the Batesville sandstone areas, being most abundant where the Fayetteville shale is entirely absent. The outcrop is prominent on the wagon road from Herd post-office to Spider Creek in 21 N., 28 W., section 14, the south part, and in section 24, the east part; on Blansett Mountain at Garfield; on the wagon road southeast of Garfield in section 33; also, around the base of the low sandstone hills west of Garfield; in 20 N., 28 W., section 14, on Poor Mountain; and on the Rock House road, in 19 N., 27 W., sections 29 and 32. In the last exposure the limestone is from 30 to 40 feet thick with considerable areal extent. Again, in the Pea Ridge region at the base of Big Mountain, near Elk Horn Tavern, the upper layers of limestone are overlain by the Wyman sandstone.

That portion of the formation exposed along Flint Creek, near the state line, is evidently near the top of the chert bed, as there is quite an area of Fayetteville shale just south of it. As this shale is somewhat above Siloam Springs that place seems to be situated near the top of the Boone chert formation.

The interstratified limestone and chert.—The chert is somewhat variegated in color; yellowish brown is the prevailing tint, but gray, white, green, black, and drab are also found. It occurs usually in slightly irregular layers from two to six inches thick, weathering into angular fragments varying from a few ounces to several pounds in weight. It is rarely seen in place except in cliffs along the watercourses, or in well-openings, but the slopes and level areas are always covered with the loose fragments. In a few places these fragments have been cemented into a breccia by a carbonate of iron, lime, or other cement, and are known locally as "made rock."

The limestone in the chert proper is not a persistent, clearly

defined bed, but consists of large quantities of limestone very irregularly distributed through the chert. In some places the limestone contains so much diffused silica that it is difficult to determine whether it should be classified as chert or as limestone. In other places the limestone is in quite irregular sheets intercalated in the layers of chert, while in still others it occurs in lenticular masses of varying sizes. Again, the chert may occur as lenticular masses in the limestone; while on the contrary the limestone may occur for miles in more or less heavy beds almost free from chert and comparatively pure. The lime quarries at Rogers and Garfield are in such beds. Unless it be on a perpendicular bluff or very steep slope, it is extremely difficult to ascertain even approximately how much limestone proportionately occurs in the strata at a given place, owing to the fragmentary chert covering the surface. Frequently what appears to be a large chert area will on examination prove to be a limestone area covered with chert fragments. From all the data that could be obtained in a study of the Boone chert area in Boone county, it seems that there is considerably more chert than limestone in this formation. Comparatively speaking, the thickness of the cherty division far exceeds that of any one of the other divisions, and it constitutes the great bulk of the Boone chert formation, while chert fragments are more or less abundant throughout the area of that formation.

The Osage Prairie region west of Rogers and south of Bentonville seems to be underlain by the middle division; while the same is true of Beatie Prairie in the northwestern part of the county.

Other exposures of limestone, noted in the Pea Ridge region, are given without reference to their precise position in the formation. The road from Bentonville to the ridge in 20 N., 30 W., descends a long, steep, cherty hill to the first ford of Little Sugar Creek, probably in section 15. This ford is more than 200 feet below Bentonville and consequently is well down in the formation. Limestone is also exposed at Mr. Maxwell's, in section 12, the southwest quarter, where the road leaves the

creek and passes up a large ravine in which limestone outcrops and fragmentary chert occurs. The point on the east line of section 1 where the road turns north to Pea Ridge is 250 feet higher than the creek at Maxwell's, showing the Boone chert to be more than 250 feet in thickness.

Otter Creek flows from the neighborhood of Pea Ridge post-office nearly due north, approximately following the line between ranges 29 and 30 W. There is limestone as well as the usual chert debris exposed in the ravine through which it flows, as for example, at Morrison's Spring in 21 N., 30 W., section 25, the southeast quarter. Limestone also outcrops along the road leading north from Elk Horn Tavern.

At the ford on Spavinaw Creek above Patton's mill in 20 N., 32 W., section 22, and again just below the mill, limestone appears in the bank of the stream. A mile below the mill the road to Nebo turns to the north and ascends a steep ravine in which the limestone is exposed. The ascent from the creek to the general level of the country must be at least 130 feet. At Nebo, which lies in the valley of a little stream, slightly below this level, there is an abundance of chert.

On the Decatur road just north of Springtown is an outcrop of limestone, some layers of which contain remarkable quantities of crinoid stems and discs, in places the layers being composed entirely of them. They vary in diameter from a quarter of an inch to three eighths of an inch, and usually stand out in relief on a weathered surface. These discs are cemented together with calcareous matter, and the interstices are filled with fragments. Some of these layers decompose very rapidly and in the grayish debris thus formed are thousands of discs completely free from the matrix. Limestone also outcrops along the Siloam Springs road on the bank of the creek immediately west of Springtown. It is quite conspicuous on account of its light color, sometimes being nearly white. Of course where the limestone is the lowest rock exposed, as it is in most of the cases mentioned above, there is the possibility of mistaking the rock of the lowest division for the limestone in the chert. This is most liable to happen

when the rock is at some distance from Eureka shale exposures.

On the left bank of the Illinois River above Robinson are some high bluffs of chert and limestone; there are also numerous outcrops on the tributaries of Osage Creek. These outcrops are not, as a rule, so conspicuous as where the denudation has been greater and the valleys deeply eroded. The disintegration of the chert layers in the many localities drained by these streams has given rise to great quantities of cherty debris, which literally covers the surface wherever the slope is sufficient for the rain to wash out the soil and other lighter products of rock decomposition.

Below the ford of Spavinaw Creek in 19 N., 34 W., section 10, on the Arkansas-Cherokee line, there is a prominent bluff, 190 feet high, known as the Red Bluff on account of the reddish brown stains near the top. The lower layers of chert in this bluff are white and light gray. There is a similar bluff above the ford on the right side of the stream in section 2.

Limestone at the base of the chert.—The limestone at the base of the chert in Benton county is the equivalent of the St. Joe marble* in the region further east. In the eastern part of Benton county it is a persistent bed from 15 to 25 feet thick, resting upon the Eureka shale and graduating into the overlying chert. Its color varies from a dark, rusty gray through all intervening shades to a reddish brown or chocolate color. As seen on the weathered exposures it is mostly lumpy, shelly, and full of seams. In a few places it is firm enough on the surface to make a fairly good building stone for rough work; and small pieces of ornamental marble may be obtained from it in some localities. The quality doubtless improves toward the interior of the bed.

Its distribution may be traced on the map by the outcrop of the Eureka shale which immediately underlies it. In many places it is concealed by the chert debris, but wherever the horizon is exposed, the limestone occurs, the chert itself in no

*For full description of the St. Joe marble see Annual Report of the Geological Survey of Arkansas for 1890, Vol. IV.

instance being in direct contact with the shale. In most of the exposures the limestone occurs in perpendicular bluffs, due partly to its position immediately above the Eureka shale, which decaying rapidly, causes the overhanging limestone to break down, and thus leaves the walls perpendicular or overhanging.

In the northern part of Benton county this stone is brighter colored, more homogeneous and more durable than in the southern part. In 18 N., 28, and 29 W., it is gray in color and lumpy and crumbling in texture. West of the wagon road in 19 N., 29 W., sections 33 and 34, in the high bluff on the north side of White River, it occurs in a continuous ledge at the base of the chert, and just above the black shale. Other prominent exposures in this township are on the lower course of Silver Spring Creek, south and southeast of Mr. Priest's mill, and in the lower part of Esculapia Hollow, at and below the big spring in section 23. On the lower course of Prairie Creek, in the northeast part of the same township, and in the southeast part of 20 N., 29 W., the limestone forms perpendicular, and in places overhanging ledges, on the north side the ledges being close to the creek; but on the south side they swing nearly a mile and a half south of it and bound the little prairie in sections 1 and 2 (19 N., 29 W.), with a prominent wall, nearly all of which is visible from the wagon road on the north side of the creek.

The limestone forms a prominent ledge the greater part of the way on both sides of the river valley below Prairie Creek. The most prominent exposures on the south or east side of the river are in 19 N., 28 W., sections 9 and 8; on the West Fork of Little Clifty Creek below the Van Winkle mill, in section 22; on the East Fork of Little Clifty Creek, in 19 N., 27 W., section 17; on the hill between Big Clifty Creek and White River, in sections 4, 5, and 6 of the same township; and on the hill opposite, in the big bend of the river. On the northwest side of the river the most prominent exposures are in 20 N., 28 W., section 32, on Pulham's Branch; on the upper courses of Ford and Cedar Creeks, in sections 14, 22, and 23 of the same township; in sections 25 and 26, on the road from

Jennings' Ford, on White River, to Poor Mountain; on the Eureka Springs-Rogers road, in 19 N., 28 W., section 1; and on the hills bordering Indian and Spider Creeks, in the northeastern part of the county.

Along the valley of Little Sugar Creek from 20 N., 31 W., section 12, to the Missouri border, the lowermost division of the limestone is exposed immediately above the Eureka shale. Persistent and conspicuous limestone bluffs occur all along this valley, and as elsewhere in North Arkansas, they constitute well-marked topographic features. The occurrence of these bluffs in this valley is so continuous that it is scarcely necessary to give detailed examples, yet one or two may not be out of place. In 20 N., 31 W., probably in section 1, the west half, there is a high and picturesque bluff, which ascends far above the shale into the middle division of the Boone chert. Again, farther down the creek, at Mr. Carrico's, in 29 N., 39 W., section 26, near the centre, there is a fine exposure of limestone with a perpendicular face 25 to 30 feet in height. The close proximity of the Eureka shale is here shown by its occurrence in a well.

Continuing across the northern part of the county, the lower layers of the limestone are encountered in the valley of Seiler's Branch of Butler Creek, at Mr. Seiler's spring, in 21 N., 32 W., section 30. Well up the sides of the valley of Butler Creek limestone outcrops above the Eureka shale are of common occurrence. A quarry has been opened in the limestone 100 feet above the town of Sulphur Springs, where the rock is rather thin-bedded, and at the top of the bluff quite flaggy. Further down Butler Creek, on the right side of the valley, above the shale, is a bluff of limestone from 25 to 30 feet thick. About a mile west of this, on the opposite side of the valley, which is here widened by the entrance of the West Fork, the lowermost layers of the limestone are again exposed, resting upon the shale. This exposure is in section 15, about 125 feet above the ford, near the Baptist church.

South of Sulphur Springs the lower strata of the Boone chert formation are well shown in the bluff above the Eureka shale, skirting the valley of Horse Creek, on the east side of

and above the old Chalk Valley or Nebo road. Here the lower layers of the limestone are from three to ten inches thick and recede to the bluff, which is fifteen or twenty feet high and composed of layers from three to six inches thick, occasionally reaching eight or ten inches. The summit of Round Mountain, two and a half miles northwest of Sulphur Springs, is also capped with limestone, resting upon the Eureka shale.

The base of the limestone is exposed on Spavinaw Creek, at and near the Eureka shale exposures heretofore mentioned in 19 N., 34 W., the northeastern part. From this outcrop, both up and down the stream, there are prominent limestone exposures, which may belong to the lower division, because of the predominance of the limestone, whereas in the middle division the chert usually prevails. There are limestone ledges along the road leading to Keith's Ford, in 20 N., 34 W., section 36, the south half. Down-stream from the shale outcrop, the bottom of the high bluff in 19 N., 34 W., section 2, is probably near the base of the formation; so also is the bluff just above the ford on the "line road," in section 10.* At the exposure in section 10 a perpendicular cliff rises 25 or 30 feet above the water. The layers at the bottom are flaggy and thin, and the creek has washed beneath, but five or six feet from the water the layers become somewhat thicker, one layer being ten or twelve inches thick; still higher the layers become thinner.

In the Illinois River valley, in the extreme southwestern corner of the county, at the O'Brien spring, near the twenty-seventh mile-post, on the Arkansas-Cherokee border, is a low bluff of limestone, immediately overlying the Eureka shale. The lower layers of this exposure are very thin. Farther up the stream at a point 150 to 200 yards below Fisher's Ford, there are low falls, caused by the river's flowing over the edge of a limestone stratum. Although not exposed, it is quite probable that the Eureka shale extends to this obstruction. At Mr. Daniels' place, in 17 N., 33 W., the northwestern portion, just below the mouth of Chambers' spring branch, a lime-

*It is reported that shale has been seen beneath this bluff at a time of very low water in the creek. It was not visible when observations were made by this Survey.

stone bluff rises perpendicularly from the water on the right bank of the river. The limestone again appears at the water's edge, and for some feet above it, along the right bank of the river, between the ford on the road to Robinson, in 17 N., 32 W., and the mouth of Osage Creek in the same township. Both of these exposures are at or near the bottom of the Boone chert formation.

Caves and sink-holes.—As might be expected from the presence of the Boone chert and limestone, there are numerous caves in Benton county, the following being the most important:

About a mile east of Electric Springs, that is, two miles from Rogers, on the right bank of Prairie Creek, is a cave in the limestone, known as Diamond Cave, which may be entered in a boat for one hundred and fifty or two hundred yards before navigation becomes difficult on account of the lowness of the roof. The cavern seems to have been formed along the line of a great crack which appears overhead in the center of the arch. A cross-section of the cave is shown in the accompanying cut. It will be noticed that there is a projecting shelf about two feet above the water.

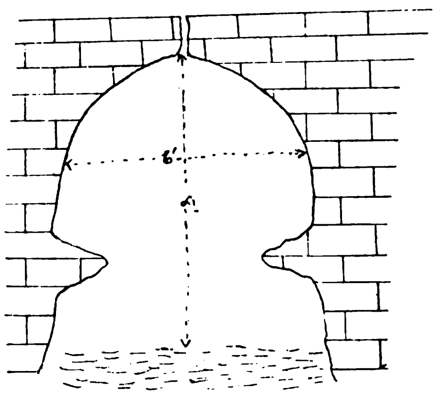


Fig. 1.—*Section across Diamond Cave, Benton county.*

A quarter of a mile southwest of Logan, in 18 N., 32 W., section 33, the northeast quarter, is a limestone bluff beneath which is a cave from which issues a large branch. There is a sink-hole a hundred yards above the mouth of the cave, in which is reported a lake of great extent.

Sink-holes occur at many places throughout Benton county, but always in the Boone chert and limestone area. Some of them are connected with caves of considerable size while others are the surface openings of underground watercourses.

CHAPTER VI.

Rocks of Benton County—*Concluded.*

THE WYMAN SANDSTONE.

Position.—In the report on the geology of Washington county* the position of the Wyman sandstone is thus defined: "The Wyman sandstone in many localities separates the Boone chert and its accompanying limestone from the Fayetteville shale. * * * It frequently forms a layer from two to three feet thick, interpolated just beneath the uppermost layers of the limestone." In that county the maximum thickness of the sandstone does not exceed nine feet, while its usual thickness is about three feet. Having been encountered there in widely separated localities the opinion was advanced that this rock was of considerable persistence; yet it is so thin that its extent is, in a great measure, undetermined. In extending the observations of the Survey into Benton county it was expected therefore, that further light would be thrown upon the distribution of this formation, and as was anticipated, it appears in several localities, but in some instances in places so widely separated that its distribution is shown to be much greater than the results heretofore obtained indicate.

Exposures.—Back of Elk Horn Tavern, at the foot of the ascent of Big Mountain in the Pea Ridge region, there are several feet of sandstone beneath the Fayetteville shale. Mr. J. C. Cox says there are eighteen inches of shale between this sandstone and the Boone chert formation. A mile or more to the west, at the north base of Little Mountain, more than two feet of sandstone are exposed, resting directly on the limestone of the Boone chert formation and overlain by the Fayetteville shale. Its presence in these mountains leads to the belief that

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV., p. 38.

it probably forms a part of the other isolated sandstone-capped elevations in this region.

North of Siloam Springs in 18 N., 33 W., section 31, the Wyman sandstone rests upon the Boone chert formation and is overlain by a black shale; its occurrence at this place was unexpected, and its limits have not yet been determined. It probably covers a large part of the northwest quarter of section 31 and extends northward into section 30, the southwest quarter, eastward into the east half of section 31, and westward into 18 N., 34 W., sections 25 and 36. The presence of this sandstone area is not only indicated by the character of the soil and fragments, but by the more substantial evidence afforded by the opening of temporary quarries, as, for example, that in 18 N., 33 W., a quarter of a mile east of the center of section 31, and that on the north side of the railroad in section 30, the southwest quarter. Not only does the stratigraphic position of these exposures conform to that of the Wyman sandstone, but the peculiar lithologic characters of the rock are also shown.

Farther north, on the road from Siloam Springs to Cherokee City at the beginning of the descent into the valley of Flint Creek, the strata are disturbed, and the road is here cut through sandstone, which shows a thickness of about ten feet, is thin layered and somewhat shaly. This is probably in 18 N., 34 W., section 23, not far from the Cherokee line.

In 20 N., 31 W., section 34, the northeast quarter, near the east line of the section, an arenaceous limestone in the road resembles the contact of the Wyman sandstone and the Boone chert. About the middle of this quarter section is a small amount of sandstone, immediately overlain by limestone, the sandstone becoming very shaly as it approaches the limestone. There are, however, but a few feet of limestone, and this is followed above by shaly, arenaceous layers. Near the line between the northeast and northwest quarters of this same section, the road passes over sandstone dipping to the southwest, then crosses a stream and ascends the bank, where there is an arenaceous deposit overlain by limestone. The occurrence of

shale at J. M. Woods' in the northwest quarter of the northwest quarter of the section leads to the conclusion that the sandy deposits at a lower level must be those of the Wyman sandstone. Fragments of sandstone in section 35, the northwest quarter, seem to indicate its presence in that locality.

Sandstone also occurs at Bentonville. There can be but little doubt that this town is situated on the very top of the great chert and limestone formation, and, while there are no exposures of the Fayetteville shale in the immediate vicinity upon which to base stratigraphic evidence, the general character of the sandstone and its relation to the chert and limestone beds confirm the belief that the Wyman sandstone again appears here. On the west line of the corporation a quarry has been opened, presenting a face with a maximum thickness of about twelve feet, with an interpolation of two feet of limestone. The deeper layers are of heavy arenaceous calcareous flagging from three to six inches thick. Again, a quarter of a mile west of Bentonville, sandstone is exposed in the Maysville road.

In the vicinity of the corporation line in the eastern part of the town, sandstone having the peculiar tint of the Wyman sandstone appears in the road. The area of this sandstone has not been determined with accuracy. It is believed, however, that the necessary data could be obtained by the study of well sections.

In 21 N., 33 W., section 32, the northwest quarter, a quarry has been opened in which six feet of rock are exposed, of which about four feet are arenaceous shale and two feet thin sandstone layers believed to be the Wyman sandstone. The latter are very useful, as the stone breaks regularly and evenly along the lines of lamination. When first quarried it is soft, but it hardens upon exposure. In this instance the sandstone is so covered that neither the stratigraphical relations, except that it is in close proximity to the chert, nor its extent has been determined. If this is not the Wyman sandstone there must be in the great chert formation a sandstone strikingly resembling it. Such, however, has not been noted farther to the east in the

region of White River, where the Boone chert has been studied, nor, indeed, in the sections exposed along the watercourses in the northern and western portions of the county. Nevertheless, such may be the case, as the following would seem to indicate. Nine and a half miles southeast of the quarry mentioned above, at the town of Decatur in 19 N., 33 W., section 11, the southeast quarter, Mr. R. J. Mathis in excavating a well at the depth of twelve feet encountered four feet of sandstone resting on chert. Sandstone also outcrops in the road in the northwest quarter of the northeast quarter of the same section. Both localities are scarcely more than a mile from the outcrop of Eureka shale in the Dry Fork of Spavinaw Creek and are not at a sufficient elevation to allow the entire thickness of the chert formation to intervene. But the shale is brought to view by a disturbance of the strata, and it may be possible that its magnitude has been underestimated from the small exposure observed, and that after all the sandstone at Decatur is the same as that appearing in the area north of Siloam Springs and elsewhere.

THE FAYETTEVILLE SHALE.

Exposures of Fayetteville shale.—The Fayetteville shale,* so abundant in Washington county, is but sparingly represented in Benton county. The only exposures of note are: in 18 N., 29 W., sections 19 and 20, on the slope of French Mountain, which lies partly in Washington county; on Blansett Mountain, south of Garfield, where, in 1890, in 21 N., 28 W., section 33, the southwest quarter of the southwest quarter, J. Y. Grammar, in prospecting for coal, put down a shaft forty-five feet, passing through twenty-five feet of Fayetteville shale. Other exposures occur in 21 N., 28 W., section 13, on the road north of Roller's Ridge school-house and on Poor Mountain. In most places east of the railway the Batesville sandstone rests directly upon the limestone, no shale intervening. Near Elk Horn Tavern the Fayetteville shale appears beneath the

*For the character of the Fayetteville shale, see Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV., p. 42.

heavy sandstone capping of Big Mountain. It is also exposed on Little Mountain, south of the west end of Big Mountain, where it occupies its normal position between the Wyman and Batesville sandstones. It is probable that the shale occurs in Callahan Mountain, southwest of Lowell, but its sides are covered with sandstone fragments derived from the decay of the sandstone cap. It is reported as outcropping in a field half a mile west of Lowell, and is exposed beneath the cap of Batesville sandstone on Lower Round Top, southwest of Robinson; likewise, on the Benton-Washington county line, at and in the vicinity of Wedington Gap in the Wedington Mountains.*

North of Siloam Springs the Fayetteville shale covers an area whose limits have not been determined. A portion of the western extension of Lindsley's Prairie is certainly underlain by it, as fragments of shale were seen by the roadside in 18 N., 33 W., section 30, the south half; and shale was also struck in digging a well in 18 N., 34 W., section 25, the northwest quarter.

THE BATESVILLE SANDSTONE.

Position and character.—The Batesville sandstone, a ferruginous sandstone, usually of a yellowish brown color, but occasionally light gray, is the highest formation in Benton county. It occurs only as a cap on the higher mountains of the county, being but a remnant of a heavy and continuous formation which once spread over the whole area. It has, therefore, long been exposed to the atmospheric agencies, which have, in some places partly, in others wholly, decomposed it.

On the tops of Poor and Little Sugar Mountains it occurs in thin shaly layers; while on the slopes of these mountains it is in strata from two to four feet in thickness. In general it is homogeneous, and weathers with a comparatively even surface. There is, however, a noteworthy exception on the road northwest of Poor Mountain, where the loose fragments of this sandstone contain numerous cavities from a quarter of an inch to

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV., p. 45.

an inch in diameter, forming a rough, pitted surface. The face of the quarry opened on Big Mountain, near Elk Horn Tavern, also presents an unusual appearance. At its top are six feet of thinly laminated sandstone, followed below by twelve feet of yellowish sandstone in which are numerous bands or concentric zones, which, when viewed from a short distance bear a remarkable resemblance, though on a far larger scale, to the graining of wood as shown on a longitudinal section. Beneath the banded layers are six feet of heavily bedded sandstone, followed by two feet of rock with the iron-stained concentric zones. Still lower, two beds of red clay are said to separate the sandstone from the underlying shale. Along the bluff on the south side of the mountain there is a large number of fragments in which iron-stained bands are well shown. In many instances the sandstone has yielded to atmospheric agencies, and the edges of the iron-stained zones stand out in relief on the exposed surfaces. Occasionally the shells of limonite are in the form of rolls several feet long.

Exposures.—The following is a list of localities where the Batesville sandstone may be examined: in 19 N., 27 W., sections 29 and 32; in 21 N., 27 W., on Little Sugar Mountain, in sections 19 and 30; in 20 N., 28 W., on Rich Mountain, in sections 2 and 11; on Humphreys' Mountain, in sections 9, 10, 15, and 16; on Poor Mountain, in sections 13 and 14; on Ratcliff Mountain, in section 17; in 21 N., 28 W., in the northeast part of the township; in section 22, the northwest quarter; on the Devil's Eyebrow; on Blansett Mountain, at Garfield; on Gentry Mountain, east of Garfield; in 18 N., 29 W., on French Mountain, in sections 19 and 20; in 21 N., 29 W., on Big Mountain; on Little Mountain; in 18 N., 30 W., on Callahan Mountain; and in 17 N., 32 W., on Upper and Lower Round Top.

Local details.—The largest areal exposure of the Batesville sandstone in Benton county is in the northeast part of 21 N., 28 W., where it covers parts of nine sections, and which is but the southern end of a larger exposure to the north in the state of Missouri. The sandstone at this place is very much decayed, that part of it enclosed by the dotted line on the map

in sections 13, 14, 15, 22, and 24 being entirely decomposed into a bed of red sand with no solid rock except an occasional boulder. In section 14, along the St. Louis and San Francisco Railway, this bed of sand is from ten to fifteen feet thick—the bottom is not exposed. A large quantity of the sand has been shipped from this point by rail. Around the eastern side of the sand area there is an outcrop of solid sandstone, some of it being firm enough for good building stone. In many places through sections 13, 24, 23 (21 N., 28 W.), and in 21 N., 27 W., section 19, the sandstone terminates in a steep ledge of solid rock, or a line of large solid boulders. The probable explanation for the solid rock on one side of the area and the sand on the other side is in the topography of the region, as the exposure on the east side terminates in the narrow ridges indented by the deep ravines of Spider and Indian Creeks, the drainage carrying away the decomposed fragments as rapidly as they are formed; while on the west side, the drainage is through the shallow, comparatively sluggish, watercourses of Sugar Creek, which are not able to remove the decomposed product.

Two small exposures of the Batesville sandstone occur on Little Sugar Mountain; one in 21 N., 27 W., section 19, the southwest quarter, and in 21 N., 28 W., section 24, the southeast quarter; the other in 21 N., 27 W., section 30, near the middle of the section, mostly in the northwest quarter. In the latter place the brown and shaly sandstone, which is 140 feet thick, weathers into a black soil, and it forms a small, conical hill, the top of which is 1770 feet above sea-level.*

In 21 N., 28 W., section 22, the northwest quarter, a short distance southeast of New Prospect Church, there is a small island of Batesville sandstone, covering but a few acres. Just south of this, in sections 22 and 27, between the railway and the wagon road from Herd post-office to Garfield, there is a larger exposure, which forms a prominent hill, known as the Devil's Eyebrow, named probably from its shape and the rough, frowning, abrupt slopes on the side next to the railway. The western slope, drained by the shallow ravines of Sugar

*Aneroid barometer measurement from Garfield.

Creek, is comparatively gentle, but the eastern slope is quite abrupt, and the ravines of Indian Creek cut deep into the side of the mountain. The railway follows closely the parting between the sandstone and the underlying limestone and chert.

A chert-covered area intervenes between the south end of the Devil's Eyebrow and the mountain nearest it on the southwest—Blansett Mountain. The sandstone exposure on the latter elevation covers parts of sections 32 and 33, in 21 N., 28 W., and in 20 N., 28 W., parts of sections 4 and 5.

In 21 N., 28 W., section 33, near the middle of the south half, the wagon road to Poor Mountain and Eureka Springs crosses the divide between the headwaters of Indian and Little Sugar Creek, passing over the cherty limestone in a narrow gap between Blansett Mountain on the west and Gentry Mountain on the east. Gentry Mountain, which extends through section 33, the southeast quarter, and section 34, the south half, on the same divide, is also capped with the Batesville sandstone. West of Garfield, in sections 30, 31, and 32, there are three small islands of Batesville sandstone, known as Williams, Henry, and Glasscock Mountains.

South and east of Little Sugar Creek, in 20 N., 28 W., on the dividing ridge between the creek and the streams flowing into White River, are several prominences covered with Batesville sandstone. The westernmost of these exposures, Ratcliff or Posey Mountain, in sections 17 and 20, is crossed by the road from Garfield to Blackburn's mill (the old Van Winkle mill), and is not so prominent as on some of the mountains to the east.

One of the largest areal exposures of the Batesville sandstone is in 20 N., 28 W., sections 9, 10, 15, and 16, forming the summit of Humphrey's or Pond Mountain. The greatest thickness of the sandstone on this mountain measures 50 feet; the average thickness, however, is much less, and most of it is greatly decomposed. A narrow chert area intervenes between this exposure and that on Rich or Ellis Mountain, in sections 11 and 2, which is likewise a thin and much decayed bed. The maximum thickness of the Batesville sandstone in the bluff on

Poor Mountain is 200 feet. On the summit it occurs in thin, shaly layers; while in places on the slopes it is in layers from three to four feet thick.

There occurs between the railway and White River but one other exposure, and this forms the summit of a mountain variously known as French, Butcher, Fitzgerald, Farr, or Osage Mountain,* lying for the most part in Washington county, but extending into Benton county in 18 N., 29 W., sections 19 and 20.

There are small exposures of the Batesville sandstone on the east side of White River in 19 N., 27 W., sections 29 and 32, where it occurs in and on the "Rock House road." Here as in the other areas described the sandstone is much decomposed.

West of the railway there are few exposures of this formation in the county, the largest being that forming the summit of Big Mountain, near Elk Horn Tavern, to which reference has already been made. The character of this formation as it occurs in this mountain is well shown in the exposure at the quarry. The top of Callahan Mountain, southwest of Lowell, is covered with this sandstone, much of which is now in a fragmentary condition.

A mass of the Batesville sandstone crowns the summit of Lower Round Top, one of the two isolated outliers of the Wedington Mountains. The exposure is in the form of a bluff, as is usual in the case of these isolated island-like elevations, and is twenty feet high. The slope is so covered with talus that the contact with the Fayetteville shale, which is also sparingly shown, cannot be determined. It seems probable, however, that the sandstone is much thicker than the exposure alone suggests. The same sandstone is exposed on the Benton-Washington county line near Wedington Gap, and it is also said to occur on Upper Round Top.

*See map of Washington county in Vol. IV. of the Annual Report of the Geological Survey of Arkansas for 1888.

CHAPTER VII.

WATERWORN MATERIALS—FAULTS.

Waterworn materials.—Waterworn boulders and pebbles occur in many places on the slopes along White and King's Rivers and War Eagle Creek far above any modern high water mark, being in some instances as much as 100 or 200 feet above the present level of those streams. The following are some of the localities in which this waterworn material is abundant: in Madison county on the hill east of the McCloud Ford of War Eagle Creek where many boulders occur, some of the larger ones weighing from 10 to 25 pounds; in 18 N., 27 W., sections 15 and 16, on the road from Clifty to Fayetteville; in Benton county in 19 N., 28 W., sections 1, 2, 3, and 11; in 20 N., 28 W., section 35; in 20 N., 27 W., sections 29 and 30; and again in Madison county on King's River, in 18 N., 25 W., section 28. At all of these places the pebbles occur on what are now the immediate slopes of the larger watercourses, with the exception of that in 18 N., 27 W., sections 15 and 16, which is on the divide between War Eagle Creek and Stanley Branch, one of its tributaries from the east.

The question arises as to the origin of this waterworn material so high above the beds of the present streams. It is evident that this area has been eroded on a grand scale—that the whole region, now so scored by the many winding watercourses, was at one time a continuous plain or plateau as shown by the continuity of the different strata. That the streams have not cut their channels vertically down to their present level is also evident. The deeper they have been eroded, the more crooked they have become; in short they have changed their stream beds and courses just as rivers and creeks are doing to-day. In these changes the waterworn pebbles and boulders have been left behind on the slopes of the watercourses

where they originally accumulated on the inside of the curves of the streams just as gravel banks and bars are formed nowadays. It may be asked, considering the long period which must have elapsed while the streams were lowering their channels 150 to 200 feet, whether these pebbles would not decay. Doubtless many of them have decayed, but when we consider the extent of the deposits and the durability of waterworn fragments as compared with angular fragments, it does not seem impossible or surprising that many of them should be preserved. At the present time there occur along the streams in this area beds of gravel from ten to twenty feet thick and several acres in extent which, except during freshets, are entirely uncovered by water. While the size of these deposits is now increasing they are gradually but constantly being left farther and farther behind by the stream. These deposits on the hills serve to indicate in many places the former bed of the stream. Inasmuch as the waterworn materials are collected on the inside of the curves of the streams, the more crooked the stream the larger the number of these deposits becomes. But the most crooked stream will tend to straighten itself, if its erosive power is sufficiently great, wherever two of the outward curves meet. Thus, in time, the confluence of War Eagle Creek and White River will be changed to a point a mile or more south of their present junction, and in 19 N., 29 W., White River will cut through the narrow hill in the north half of section 35 and flow directly through sections 35 and 36, instead of through the loop in section 26, as at present. In this case two or three miles of river deposits will be left to mark in future ages the former course of the stream. White River formerly flowed in 19 N., 28 W., through the southern portion of sections 2 and 3, instead of through the bend to the north as at present. This is shown not only by the waterworn debris left on the surface, but by the contour of the hills.

The source of the waterworn materials on the divide between War Eagle Creek and Stanley Branch, in 18 N., 27 W., to which reference has been made, is the same as that on the slopes in the immediate vicinity of the creek. The presence of this mate-

rial to the west on the north side of the creek, and its absence on the south side, show that at this point the creek has been cutting its way to the south. While, then, it is true that these deposits of pebbles occur on the top of a divide, they are no higher above the present water-level than other deposits in the immediate neighborhood; hence it is not necessary to imagine a greater erosion by the stream in the one case than in the other. If, in connection with these facts, it is assumed that the shallow valley of Stanley Branch has been eroded subsequent to the deposition of the gravels, the occurrence of the gravel here is only a slightly modified condition of its occurrence in other places.*

The observer cannot fail to be impressed with the remarkable regularity of the strata in this county. Faults are almost wanting, and there are comparatively few well marked folds. It is true that some of the exposures of the Eureka shale, as on Spavinaw Creek, result from slight undulations of the strata, but even these are rare.

Fault.—There is a small fault, the extent of which is not known, on the east prong of Little Clifty Creek, in 19 N., 27 W., section 17, the southeast quarter, about a quarter of a mile below the big spring. The line of fracture is clearly visible on the southwest bank of the creek, opposite the mouth of a small tributary which enters it from the northeast. The displacement is estimated at fifty feet, with the downthrow on the south side. On the north side the saccharoidal sandstone is exposed, dipping ten or fifteen degrees to the southeast. Abutting against the sandstone on the south side of the fault is the limestone at the base of the Boone chert formation, dipping from five to eight degrees in the same direction. The line of fracture can be traced a short distance up the tributary by the saccharoidal sandstone exposure on the northwest side, and by the limestone outcrop close to the watercourse on the southeast side. In less than half a mile, however, the fracture

*The localities mentioned in this description on War Eagle Creek and King's River are shown on the Eureka Springs sheet of the map accompanying Vol. IV. of the Annual Report of the Geological Survey of Arkansas for 1890.

is concealed by the broken chert. The dip too is noticed for only a short distance up-stream (above the fault), the rocks soon regaining a comparatively horizontal position. Down-stream from the fault the sharp south dip continues for nearly a mile, the Silurian rocks reaching a height of 100 to 125 feet above the creek in section 17 (19 N., 27 W.), the west half, but again falling, on account of a bend in the creek, to fifteen or twenty feet in section 18, the south half. In the west half of section 18, the Silurian rocks are exposed to a height of over 200 feet, and the creek flows northward against the dip of the rocks. On account of the presence of the chert debris, which almost completely conceals the strata in places, it is impossible to trace so small a displacement through the hills. Gentle folds occur on the west prong of Little Clifty Creek to the west, and on Big Clifty Creek in Carroll county, to the east, but no displacement has been observed at either place.

CHAPTER VIII.

Economic Geology.

BUILDING STONES.

Good building stone may be obtained in Benton county from the Batesville sandstone, from the limestones of the Boone chert formation, and from the magnesian limestones.

Sandstones.—The Batesville sandstone is a good, durable, and easily wrought stone for building purposes, and is especially valuable for local use in the building of chimneys, foundations, and similar structures. That quarried on Big Mountain near Elk Horn Tavern, was used by the St. Louis & San Francisco Railway in the construction of culverts, abutments, etc. Although not distributed over a large part of Benton county, each outcrop is available to a comparatively large neighborhood, as it occurs on the tops of hills, thus giving a down grade in every direction for transportation. As already stated, this rock is in places much decomposed, yet in nearly all the area shown as Batesville sandstone on the accompanying map, good building stone may be found. This is especially true of the heavier outcrops on Poor Mountain and Little Sugar Mountain. No building stone will be found inside the dotted line enclosing the large area adjoining the state line in 21 N., 28 W., as the rock is completely decayed. The resulting sand, while not the best for the purpose, may be found useful for making mortar or plaster.

A sandstone is quarried half a mile north of Siloam Springs, in 18 N., 33 W., section 31, which occupies the position—just beneath the dark Fayetteville shale—of the Wyman sandstone in Washington county. This soft sandstone is easily worked, and is said to harden upon exposure.

The saccharoidal sandstone at the top of the Silurian rocks is generally too friable and too massive for good building stone,

yet in a few places, where it is thin-bedded and has long been subjected to the action of waters carrying iron, it makes a fairly good building stone. In most places it can be easily crushed into sand, which from its cleanness and sharpness is valuable for plastering and similar purposes. In the northwestern part of the county, where there is a great excess of chert and limestone, sand for mortar and plaster is obtained in this way. Small pits have been opened for obtaining sand from the sandstone along the line of fracture, near the eastern edge of Beatie Prairie, east of Maysville.

Limestones.—Limestone for building may be obtained from any of the three kinds described in the Boone chert. The area of the upper bed, that immediately underlying the Batesville sandstone, is more limited than the others, and in many places it is too thin to quarry profitably; in all the outcrops its greater density and tenacity render it more difficult to work than either of the others. It is doubtful if it could be quarried in dimension stone with profit.

The limestone at the base of the chert, while strong and durable, is full of seams, which mar its value for fine work. It occurs in layers from a few inches to two feet in thickness, and is easily worked.

The limestone in the chert bed, where it occurs in sufficient thickness and free from chert, is a more valuable building stone than either of the others, being more evenly and not so heavily bedded as that at the top, and more nearly free from flaws than that at the bottom. In places it furnishes a marble suitable for tombstones or for architectural purposes. It is easily wrought, and takes a fine polish, looking well with either a rock face, a tool-dressed, or a polished surface.

The magnesian limestone (popularly known as "cotton rock"), where it occurs free from chert, is the most valuable building stone in the eastern part of Benton county. It occurs in regular, evenly bedded layers of convenient thickness for quarrying (from three inches to two feet), takes a good finish, and is more easily dressed than any of the other stones in this area. It is soft and easily cut when first quarried, but hardens on ex-

posure. Its remoteness from the railway and from the towns has so far prohibited its use.

LIME.

The Rogers lime-kiln.—Lime has been burnt near Rogers, in 19 N., 29 W., section 7. There is one kiln now in operation the top of which is 110 feet below Rogers, and another small one which has fallen into disuse. The proprietor at the present time (March, 1892) has controlled the kiln about three months. During one month of this time 3000 bushels of lime were burnt and shipped to various points in Arkansas and Indian Territory. The stone in the quarry is quite bituminous, coarsely crystalline, and fossiliferous. The largest face exposed in the quarry is eight feet, in which occurs from four to six inches of chert in small lenticular masses and irregular layers. An analysis of the limestone shows it to contain 98.02 per cent. of carbonate of lime and 0.13 per cent. of carbonate of magnesia. The sample analyzed is the average of numerous specimens chipped from various parts of the quarry.

The Garfield lime-kiln.—One mile northwest of Garfield on a tributary northwest of Sugar Creek is a quarry at which much lime was burnt a few years ago. The kiln is on the north side of the creek and the quarry on the south side. A tramway was used to convey the stone from the quarry to the kiln, and another was used to carry the lime from the kiln to the railway at Garfield. The limestone, which belongs to the Boone chert series, has a quarry face of 40 to 60 feet with some intercalary and nodular chert. No analysis has been made of the limestone, but it probably varies but little from that at Rogers.

From February 1884 to November 1886, the quarry at Garfield was operated by Peel and Benn, who sold during that time 86,300 barrels of lime and 50 car-loads of bulk lime. In 1887 the property came into the possession of H. S. Dean, who in 1887 and 1888 shipped 15,000 barrels of lime and a few car-loads of bulk lime. The principal shipping points from this quarry were Fort Smith, Van Buren, and Little

Rock, Arkansas; and Wichita, Newton, Hutchinson, Dodge City, Emporia, Mulvane, Winfield, Wellington, Halstead, and a number of smaller towns in Kansas. The quarry, which now belongs to the heirs of H. S. Dean, has not been in operation since the fall of 1888.*

No other kilns are reported in Benton county; but small quantities of lime for local use have been burnt in many places by the primitive method of piling the broken stone on a log heap and firing the mass.

About a mile north of Bentonville, on the road to Little Sugar Creek, there is an old kiln, now in disuse, which was supplied from the limestone of the Boone chert formation.

Any of the limestones in the Boone chert will make good lime. The economy of producing it varies with the facilities for quarrying the rock and the time used in burning, the more crystalline varieties requiring more heat to calcine them. The magnesian limestones when burnt would, of course, make a magnesian lime, which at present is not in favor in this country.†

CLAYS.

Clays suitable for brickmaking occur in different portions of the county. At Rogers two brick-kilns use the residuary clay from the decomposed chert. Much of the alluvial deposit along White River and clay from the decayed Fayetteville shale furnish good brickmaking material. The clays derived by decomposition from the argillaceous shales and the argillaceous shales themselves are available for the manufacture of vitrified bricks—an industry which has lately become important on account of the demand for such bricks for road pavements in cities. The Eureka shale could also be used for the manufacture of common alum.

SOILS.

In Benton county there are several varieties of soil, resulting

*For the statistical information regarding the Garfield lime-kiln the Survey is indebted to Hon. J. B. Lamkin of Garfield.

†For further particulars on the lime industry, see Annual Report Geological Survey of Arkansas, Vol. IV., 1890, Chapter XI.

from the decomposition of the different rock formations. The soil from the Batesville sandstone covers rather limited areas, mostly between the railway and White River in the eastern part of the county. The Batesville sandstone is the uppermost formation of the county and consequently occurs on the summits of the hills and mountains. In these places the soil formed from the sandstône alone is light and not very fertile, but around the borders of these elevations, where the sand is mixed with the decayed limestone and chert of a lower formation, a remarkably fertile soil is formed. The soil from the Batesville sandstone would in most places have its fertility increased by the addition of lime.

By far the larger part of Benton county is covered with the soil derived by disintegration from the Boone chert, the fertility of which depends in a great degree upon the presence of limestone. A very fertile soil composed of the remnants of the Batesville sandstone, the underlying shale, and possibly the Wyman sandstone, mingled with the decaying chert, occurs in the flat or rolling country near the top of the chert formation. In many places in the county, where the declivity is sufficient, the finer ingredients of the soil have been washed away by the rain, leaving the steep slopes covered with angular chert fragments. While many such areas are fertile, they are too rough to be farmed with profit. However, when the slope is sufficiently gentle to permit the retention of the bulk of the decomposed rock, the chert areas are quite fertile. In some of the prairies there still seems to be defective drainage, and in consequence the soil is cold and unproductive. When the drainage of such places is remedied the land will be greatly improved.

The soil resulting from the decay of the saccharoidal sandstone is practically barren, as this sandstone is almost pure silica and has no elements of fertility. However, but little of this soil occurs, as the sandstone outcrops in perpendicular ledges along the steep-sided watercourses where the sand is carried away as fast as it is set free.

The magnesian limestones make a productive soil. However, there are but few areas of it in the county sufficiently

level for agricultural purposes. Of these, mention may be made of the prairie at the mouth of Prairie Creek in 19 N., 29 W., the northwest part; and the rolling country about Rocky Branch in 19 N., 28 W., the northeast part. Small areas suitable for cultivation also occur on the magnesian limestones along the White River hills; on Indian Creek and Spider Creek, in the northeast part of the county; and along Butler Creek, in the northwest.

The Fayetteville shale and the Eureka shale which are so sparingly represented in Benton county do not contribute much to the formation of the upland soils, both on account of their thinness as formations and their stratigraphical position. Wherever the Fayetteville shale appears, with a single exception, it forms a slope receding from beneath a sandstone-capped hill; and in these limited areas the soil is a result of the commingling of the disintegrated sandstone and the decomposed shale. Just north of Siloam Springs there is a small area not far above the great limestone formation, where this shale seems to have contributed largely to a thin and not very productive soil, closely resembling that in the valley south of Fayetteville.

The Eureka shale contributes but little to the upland soils, as its outcrops are usually along the margins of streams or at the bases of limestone bluffs. In the first situation the fragments are borne away by the water, comminuted, and their identity lost in the great mass of silts and alluvial deposits; in the second case they are usually buried beneath an accumulation of chert and other fragments of less soluble materials from the overlying formations.

The soil in the river bottoms is very productive, and constantly remains so, owing to occasional overflows.

LEAD AND ZINC.

The occurrence of lead and zinc has been reported at several localities in Benton county. As yet, however, none of the prospects indicate valuable deposits. However, there is no geological reason why both lead and zinc should not be found.

as they are both well-known limestone minerals and the Boone chert is of the same age as the rocks in which these minerals occur so abundantly at and about Joplin, Missouri.

ROAD-MAKING MATERIALS.

With the exception of the Eureka shale and the Fayetteville shale, all of the rocks found in the county furnish good road-making materials. First in order of merit stands the chert, which, when crushed, forms an excellent top dressing for roads. Then, too, it is so widely distributed that it can be readily obtained in almost every part of the county. Next may be mentioned the limestones, which broken to the proper size furnish excellent materials for the bottom of macadamized roads, but they are not suited for top dressing (though often so used), and should always be covered with some siliceous rock.

OIL AND GAS—THE DEEP WELL AT FAYETTEVILLE.

Inquiries are often made of the Geological Survey regarding the chances of finding oil and gas in Benton county. But one answer can be given such questions and that is an altogether unfavorable one. The same questions have been asked and answered regarding Washington county, of which the geological structure is practically the same as that of Benton county. But notwithstanding the Survey's advice,* an expensive deep well (1480 feet) was put down at Fayetteville in 1891 in the hope of finding oil or gas, or both, or artesian water at least. Neither was found, and though water appeared at various levels it always failed to reach the surface.

Inasmuch as the succession of rocks in Benton county is the same as in Washington county the record of the Fayetteville well is given here. This record furnishes valuable and interesting detailed information regarding the order and thickness of the various formations passed through. The results of the venture should also be of value to those who are disposed

*See Annual Report of the Geological Survey of Arkansas for 1888, Vol. IV., pp. xiv. and 126.

to disregard opinions based on geological structure in favor of the advice of those who depend on "indications."

The Fayetteville deep well was sunk by the Washington County Mining Company to a depth of 1480 feet. The site chosen was in 16 N., 30 W., section 15, the southwest quarter of the southwest quarter, on a lot forming a part of block 3 of the Nathan Combs Addition to the city.

Through the courtesy of Messrs. I. W. Duncan and J. W. Mayes, President and Secretary of the company, the Survey had an opportunity of examining the record kept by the company and nearly all the samples originally collected. Fortunately the drillers were instructed to make note of every change in the character of the rock encountered and to save specimens, nearly all of which were kindly furnished the Survey. No member of the Survey was present while drilling was going on and the samples were examined a year after the drilling was done. In the meantime some of them had become altered in their appearance through rust.

Record of the deep well at Fayetteville.

Feet below surface.	Thickness in feet.	Character of the rock.
	20	Soil.
	44	Disintegrating shale.
64	114	Black shale, partly calcareous.
178	7	Black shale, containing carbonate of lime; the record says this shale is very hard.
185	6	Limestone and black shale, the latter probably from a higher point in the boring.
191	7	Gray and white limestone together, with fragments of black shale from a higher level.
198	90	Flint and gray limestone; some fragments of shale.
288	24	Flint and light gray limestone, rusty from oxidized iron pyrites.
312	36	Chert and carbonate of lime, light-colored, almost white, containing minute fragments of oxidized pyrite.
348	38	Chert and carbonate of lime, like the preceding.
386	20	Limestone, very light-colored, about 50 per cent. chert.
406	14	Limestone, now rusty; original color probably much lighter.
420	40	Limestone of a light drab-gray color; the record says it is very hard.

Feet below surface.	Thickness in feet.	Character of the rock.
460	24	[illegible] gray chert with oxidized pyrite.
484	22	Compact chert with calcareous streaks and containing numerous crystals of pyrites.
506	6	Limestone, dark gray, [illegible] base of the [illegible] limestone.
512	46	Black Eureka shale with crystals of copper pyrites; the record says [illegible]
		[illegible] parting.
558	22	[illegible] gray limestone with fragments of shale.
578	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] saccharoidal [illegible]
[illegible]	[illegible]	[illegible]
7[illegible]	[illegible]	[illegible] the preceding.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
87	[illegible]	[illegible] fragments [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	1[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
975	5	[illegible] particles [illegible] pyrite.
[illegible]	[illegible]	[illegible]
[illegible]	15	[illegible]
1000	25	Light gray limestone with [illegible]
1025	15	Light gray limestone with chert, [illegible] less abundant than in the preceding.
1050	20	Limestone and flint, as in stratum immediately above.

Feet below surface.	Thickness in feet.	Character of the rock.
1060	10	No sample; recorded as "lime and flint."
1070	5	White limestone.
1075	10	Light gray limestone.
1085	5	Light gray limestone with flint, somewhat rusty.
1090	10	Similar to those preceding, but with less flint.
1100	10	Very light gray limestone.
1110	15	No sample; recorded as "white lime."
1125	15	Very light gray limestone.
1140	20	Light gray limestone.
1160	40	Light gray limestone with some chert and pyrite.
1200	..	Gray limestone and flint.
1210	..	Gray siliceous limestone; 22.31 per cent. of insoluble matter.
1220	..	Gray siliceous limestone; 13.57 per cent. of insoluble matter.
1230	..	Magnesian limestone, dolomite; 17.64 per cent. of insoluble matter.
1240	..	Light gray limestone, now somewhat rusty.
1250	..	Limestone; 14.52 per cent. of insoluble matter.
1275	..	Light gray limestone with a little flint, rusty.
1285	..	Limestone; 8.74 per cent. of insoluble matter.
1310	..	Light gray cherty limestone, containing oxidized pyrite; 21.24 per cent. of insoluble matter.
1325	..	Limestone; 22 per cent. of insoluble matter.
1360	40	Gray limestone, darker than in second stratum above.
1400	10	Brownish gray or drab limestone; 4.06 per cent. of insoluble matter.
1410	10	Light gray limestone with some flint.
1420	15	White or very light gray limestone with a little flint.
1435	10	Limestone, slightly darker than the preceding, with a little flint.
1445	5	Drab-gray limestone, somewhat rusty.
1450	10	Light drab-gray limestone.
1460	20	Drab-gray limestone with very little flint.
1480	..	Drab-gray limestone, now very rusty. Bottom of the well.

Summary.

Formation.	Thickness in feet.
Soil	20
Fayetteville shale	165
Boone chert and limestone	327
Eureka shale	46
Sylamore sandstone, Saccharoidal sandstone, Magnesian limestones, etc.,	922
Total	1480

CHAPTER IX.

General Information Regarding Benton County.

Organization.—Benton county was originally a part of Washington county, from which it was separated by act of the Legislature in 1836. It occupies the northwest corner of the state, being bounded on the north by McDonald and Barry counties in Missouri; on the east by Carroll and Madison counties; on the south by Washington and Madison counties; and on the west by the Cherokee Nation of Indian Territory. It embraces about 877.40 square miles or 561,542 acres,* of which 382,940.70 acres appear as taxable lands on the record for 1890, and 392,597.74 acres on that for 1891.

Resources.—The resources of Benton county are exhibited in the following table, compiled from the assessment books for 1890 and 1891:

Assessed value of the property of Benton county.

	1890.	1891.
Value of land	$ 1,581,203	$ 1,600,390
Value of city or town lots	449,450	471,895
Value of railroads	187,260	200,912
Value of personal property	1,355,674	1,399,715
Total	$ 3,481,607	$ 3,673,712

Population of Benton county.

In 1870	13,831
In 1880	20,328
In 1890	27,716

Cities and towns.—Bentonville, the county seat of Benton county, was founded in 1837, and has now a population estimated at 2500. It is on the northern border of the Osage Prairie region in 20 N., 30 W., the southwest corner, and occupies a portion of sections 29, 30, 31, and 32. It is connected

*From note accompanying S. B. Robertson's map of Benton county.

with the St. Louis & San Francisco Railway at Rogers by the Bentonville Railway, a branch six miles long. Another road giving a north and west connection is in process of construction. This town is in the fruit region of North Arkansas. It maintains two large evaporators, and from it 350 car-loads of fruit of various kinds were shipped in 1890.

Rogers, a town six miles southeast of Bentonville, rivals Bentonville in thrift, business enterprise, and general importance. It is a new town, established as late as 1881, on the line of the St. Louis & San Francisco Railway, which was then building. The principal part of the town lies in 19 N., 30 W., section 12, and in 19 N., 29 W., section 7. Its population is estimated at 2000. At the present time Rogers is the most important railway station in Benton county, receiving freight from, and distributing it to places even more remote than Siloam Springs.

Siloam Springs (Siloam City) is situated in the southwestern part of the county, adjoining the old Hico settlement, 27 miles southwest of Bentonville. The greater part of the town is in 17 N., 33 W., section 6. The springs were at one time thought to equal those at Eureka, and in 1879 a town, called Siloam City, was established. In 1881 its population is said to have exceeded that of any town in the county, having been estimated at 3000. Now, however, it is doubtful if it has half that number. The town is upon the proposed line of the southern extension of the Kansas City, Fort Smith & Southern Railway.

Sulphur Springs is also a new town, the first survey for which was made in 1885. It is on Butler Creek in 21 N., 33 W., section 34, the southwest quarter, seventeen and a half miles by wagon road northwest of Bentonville. Besides its attractive scenery and the springs, it has the advantage of being connected by rail with Neosho and Joplin, Missouri. At present (1892) it is the terminus of the Kansas City, Fort Smith & Southern Railway. Its population is estimated to be between 500 and 600.

Springtown, situated on Flint Creek near a very large spring,

from which it takes its name, is eighteen miles southwest of Bentonville on the road to Siloam Springs. Its population is estimated at 210.

Other places of importance in Benton county are Garfield, on the St. Louis & San Francisco Railway, thirteen miles northeast of Rogers; Avoca, a station on the same road, six miles southeast, and Lowell, a station five miles south of Rogers; Maysville, an old town on the Indian Territory border (twenty-six miles from Bentonville), which was almost annihilated by a conflagration on March 11, 1891; Rome City, a new town a quarter of a mile south of Maysville; Nebo, on the Maysville road sixteen miles from Bentonville; Decatur, Bloomfield and Cherokee City in the western part of the county between Spavinaw and Flint Creeks; Pea Ridge, nine and a half miles northeast of Bentonville and a few miles west of the Pea Ridge battle ground; Robinson, on the Illinois River, southwest of Bentonville and near the Washington county line; Osage Mills and Wager's, on Little and Big Osage Creeks respectively; and War Eagle Mills, southeast of Rogers and east of White River.

Railways.—The St. Louis & San Francisco Railway crosses the county east of the center, following the divide between the White and Arkansas River systems. It enters in 21 N., 28 W., section 14, the northwest quarter, and runs in a southwest course to Rogers, thence south to Springdale and into Washington county. This railway was built in 1881.

Bentonville, the county seat and principal town, having been thus left six miles from the railway, felt the need of a closer connection than the county roads afforded. Accordingly the Bentonville Railway Company was organized and in 1883 a branch line was built to the town of Rogers.

The Kansas City, Fort Smith & Southern Railway, of which fifty-five miles have been constructed, from Joplin, Missouri, to Sulphur Springs, Arkansas, will undoubtedly be extended at least to Fort Smith. It now penetrates Benton county to the distance of only a mile and a half. The route

proposed will take it nearly due south across the county from Sulphur Springs.

Post-offices.—The following is a list of the post-offices in Benton county in 1892:

Post-offices in Benton county.

1.	Avoca.	14.	Gallatin.	26.	Parn.
2.	Beaty.	15.	Garfield.	27.	Pea Ridge.
3.	Bentonville.	16.	Herd.	28.	Puckett.
4.	Bloomfield.	17.	Hico.	29.	Robinson.
5.	Brightwater.	18.	Larue.	30.	Rogers.
6.	Buttry.	19.	Logan.	31.	Seba.
7.	Cannon.	20.	Lowell.	32.	Siloam Springs.
8.	Cherokee City.	21.	Mason Valley.	33.	Silver Springs.
9.	Colville.	22.	Maysville.	34.	Sulphur Springs.
10.	Creech.	23.	Nebo.	35.	Trident.
11.	Crump.	24.	Osage Mills.	36.	Wager.
12.	Decatur.	25.	Pactolus.	37.	War Eagle Mills.
13.	Dickson.				

Climate.—The climate of Benton county is remarkably fine and healthful, the effects of altitude and the barrier imposed by the Boston mountains, being as marked here as in Washington county.

There is a great difference between the climate north of the mountains and that south of the mountains—a difference due chiefly to the great difference in altitude. For example, Van Buren, on the Arkansas River, is but 439 feet above tide, while Winslow, the highest point on the St. Louis & San Francisco Railway, thirty-five miles distant, is 1735 feet; Fayetteville, fifty-seven miles north, 1340 feet; Rogers, seventy-seven miles, 1385 feet; and Garfield, ninety miles, 1519 feet. The climate and the vegetation of northwest Arkansas are pleasant combinations of those of both the northern and southern states. The summers and winters are comparatively short and the springs and autumns long and delightful.

Rainfall.—There is usually an abundance of rain in Benton county, the rainfall occasionally being very heavy, but seldom so great as to cause destructive freshets. The topography is such that the surplus water runs off rapidly; as a result the

rivers and creeks are liable at times to become very much flooded, but whatever damage is done by freshets is confined to the bottoms.

Timber.—The eastern part of Benton county is not heavily timbered, many of the slopes in the Silurian area being almost bare, having but a scanty covering of black-jack, persimmon, and post-oak. The ridges in the chert area are mostly covered with a growth of black-jack, or scrubby post-oak trees. A heavy growth of hard wood timber occurs on such parts of the White River bottoms as are not under cultivation. There is a growth of large white oak, black oak, walnut and hickory on Humphrey Mountain in 20 N., 28 W., sections 10 and 15, and around the heads of some of the terminal ravines on other mountains; this is especially the case on Poor Mountain, in the same township. There is much cedar on the river bluffs and the bluffs along some of the larger creeks. Yellow pine occurs on the ridges in 19 N., 28 W.

West of the St. Louis & San Francisco Railway are the prairies of the county, along the borders of which in many places a growth of young timber has sprung up. There are also good growths of trees at various points along the Illinois River and other streams. As a rule, however, this portion of the county is not heavily wooded.

Farm products.—In Benton county the more important crops are Indian corn, oats, and wheat. Some attention is given to tobacco culture. Vegetables, too, are easily grown, and the grasses and forage plants do well.

Fruits.—Apples are the principal fruit grown in Benton county. The fact that the county was awarded the highest prize at the exhibitions at New Orleans, St. Louis, Riverside, California, and Boston, for the finest display of apples, is strong testimony of the excellence of its fruit. Next in importance are the peaches, of which there are occasionally enormous crops. In 1891 the crop was so large that much of it was not even gathered, the evaporators having become overstocked.

The smaller fruits, as the strawberries, blackberries, and raspberries, find here a climate adapted to their growth. With the

increased facilities for reaching the markets which the railways now building, or in contemplation, will afford, there will undoubtedly be a greater demand for this class of products.

The following statistics of strawberries were furnished by Mr. S. B. Wing, of Rogers, Secretary of the Washington and Benton Counties Fruit Growers' and Shippers' Union. In the spring of 1891, twenty-nine car-loads, averaging 600 crates to the car, were shipped from Garfield, Avoca, and Rogers, in Benton county, and Springdale, in Washington county, to Kansas City, Sioux City, St. Paul, Omaha, and Denver. In 1892, when the season, on account of the prolonged rains, was unfavorable to small fruits, the shipment was nineteen car-loads.

Strawberries shipped from Benton county in 1892.

Station.	Crates.
Garfield	3,532
Avoca	2,732
Rogers	2,800
Total shipments	9,064

These figures indicate only the shipments in car-load lots. To them should be added the shipments by express, for which no statistics have been obtained.

Educational advantages.—There are in Benton county 137 school districts, in which school is taught on an average four months in each year. In Bentonville there is an excellent school building; Rogers also is provided with a good public school building. In addition to the public schools there are in the county two academies or colleges maintained by private enterprise, one at Pea Ridge, northeast of Bentonville, and nine or ten miles by wagon road from Avoca, the nearest railway station; the other at Rogers. The first is under the auspices of the Christian Church, and the second under the Congregational Church.

ELEVATIONS IN THE STATE OF ARKANSAS.*

BY JOHN C. BRANNER, State Geologist.

The important purposes which accurately determined elevations serve or may serve are sufficient reasons for the publication of all the spirit levels that the Survey has been able to determine, and to compile and refer to mean tide level.

I. They often aid in comprehending both the details and the general features of geologic structure, and thus throw light upon important economic problems.

II. They are essential as furnishing the basis of accurate topographic representation.

III. They are available for use by engineers in road and railway building, in seeking water supplies, in draining and in hydraulic engineering generally.

IV. They may serve to detect and to determine changes in the elevation on the crust of the earth.

There are times when the accuracy and value of geologic work depends very largely, indeed it may be said, almost entirely upon the element of vertical distance, or difference of level. These differences of level are measured by methods which vary, or should vary, according to the degree of accuracy required in each case. Sometimes the aneroid barometer is sufficiently accurate; at other times measurements by the use of vertical angles answer; in other cases lines of flying levels will serve, while in still others the highest degree of accuracy obtainable with the spirit level is needed. The elevations

*The law establishing the Geological Survey specified as one of its functions that it should determine "the relative elevation and depression of the different parts of the State." Acts of 1887, p. 57.

given in the present report are therefore grouped according to the degree of accuracy with which they have been determined under the following heads:

I. Precise levels.

II. Railway or ordinary spirit levels.

III. Elevations determined and checked by barometer.

I. PRECISE LEVELS.*

Where geologic and topographic work is planned with a view to its unity over the whole state, as it has been here in Arkansas, it is necessary that all elevations be referred to a single datum, and that this datum be the one which is used by common consent the world over, and which will therefore be most useful in the long run, namely the mean or average level of the ocean along its shores, usually called "mean tide." Inasmuch as all side lines must depend upon the accuracy of the primary line by which the precise elevation is brought up from tide water, it is of the highest importance that this line be run with the greatest possible care, and that it be as near as possible to absolute accuracy. The use of the mean tide datum makes available for reference and comparison all work of a similar nature done in adjacent states and in other parts of the world. It was therefore determined that all the topographic and geologic work of the Survey should be based upon the most trustworthy and most useful data. In order to establish the required bench-marks, or points of reference, it was necessary to carry up a line of levels from the Gulf of Mexico to some point or points in Arkansas. The railway levels along lines entering the state from tide water are run with the degree of accuracy demanded by railway work, but they are not what are known as "precise levels," and are therefore available as secondary, but not as primary lines of levels. The running of a line of precise levels must be done with all the care and refinement of the most accurate methods

*For a description of the methods and instruments used in running lines of precise levels, see reports of the United States Coast and Geodetic Survey for 1879 and 1880.

known, and is necessarily a slow, tedious and expensive piece of work; to carry it up from the Gulf of Mexico and to establish bench-marks across the state from east to west and from north to south would require a large sum of money, and one which the State Geologist has not felt warranted in spending upon work entirely preliminary to the immediate objects of the Geological Survey.

In July, 1887, Gov. Hughes asked the co-operation of the United States Coast and Geodetic Survey in the determination of elevations in this State under the provision made by Congress for the determination of points for State surveys. The superintendent wrote in reply to Gov. Hughes' request that the whole of the small appropriation for "furnishing points for State surveys" for the current fiscal year, except a small amount reserved for contingencies, had already been allotted to work in other States, so that no funds would be available for use in Arkansas until Congress should have made another appropriation for "furnishing points for State surveys."

In view of the urgent necessity for these elevations the State Geologist conferred in person with the superintendent of the United States Coast and Geodetic Survey, who wrote under date of August 20th "that an amount sufficient for the purpose indicated (the determination of an elevation at Little Rock) will be allotted from funds available, and as soon as the season and the exigencies of present work will permit, an officer of this Survey will be assigned to establish in altitude the desired point at Little Rock." This work was therefore begun in October, 1887, and the elevation established at Little Rock in February, 1888, the line having been run from Arkansas City to this place along the line of the Little Rock, Mississippi River and Texas Railway. Upon my request, and after representing to the Superintendent of the Coast and Geodetic Survey the utility and necessity of such work to this Survey, another party was sent in August, 1888, to carry the line from Little Rock to or toward Fort Smith along the line of the Little Rock and Fort Smith Railway.

By means of precise levels elevations above mean tide have

thus been determined and permanent bench-marks established along a line from Arkansas City, Desha county, to Fort Smith. Another line is also being brought from the transcontinental line in Missouri by way of the St. Louis and San Francisco Railway to Fort Smith. The cost of this work has amounted to many thousand dollars, an expense, however, of which the State has borne no part. The descriptions, locations and elevations of the bench-marks thus established are given in the following tables.

If lines of levels run for any purposes whatever in the neighborhood of any of the bench-marks mentioned in this list be based upon these elevations, we shall gradually accumulate in the State data of great value to geologists and to engineers, and to the people and the enterprises of the State generally.

In the lists of these levels only the permanent bench-marks are mentioned, and such descriptions are given of each bench-mark as will enable any one to readily find it.

II. RAILWAY OR ORDINARY SPIRIT LEVELS.

Next in importance after the precise levels are the spirit level lines usually run in the course of the surveys for railway construction. These lines have been run by engineers at great expense, and are made available and accessible they might often be of general utility to the people.

It is not of course essential to the purposes for which these lines were originally run that they be referred to the sea level so long as they showed the relative elevations of points along the lines surveyed. Many of them have therefore been based upon some convenient assumed datum. For the purpose of having them all directly comparable these elevations have been collected and the elevation of the assumed datum has been determined and the entire lines thus connected into one common and uniform system, that is, they are referred to mean sea level. The importance of such connected lines of levels in engineering operations of various kinds, such as hydraulic engineering and railway building, need not be pointed out here.

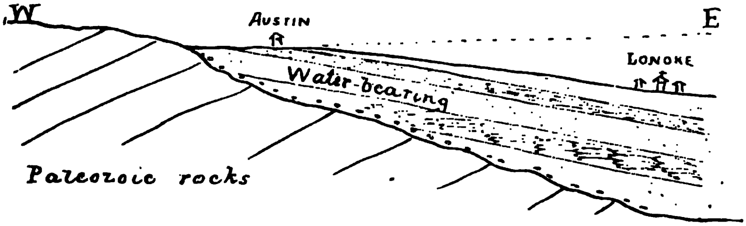
The great importance of elevations in geologic work, for to-

pographic representation, and for comprehending both the details and the general features of structural geology, has already been referred to. A couple of illustrations of the practical applications of connected lines of levels over the state to geologic investigations will not be amiss here. The State Geologist is frequently called upon to express an opinion regarding the possibility of obtaining artesian water in the eastern part of the state. The decision of this question must be based upon two things:

1st, the structural geology of the region in which it is proposed to sink the well, and the geologic relations of the region in question to adjacent areas.

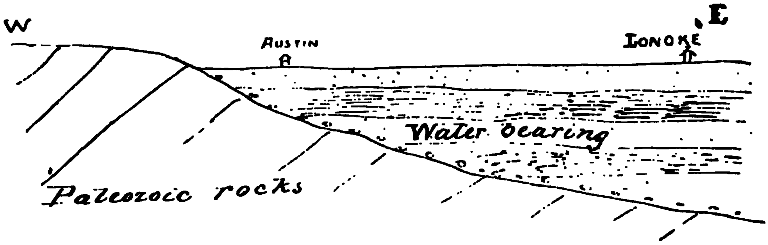
2nd, the differences of elevation over the region affecting the water supply.

Let us suppose by way of illustration that Lonoke is the point at which it is proposed to put down an artesian well. Lonoke is in a region of soft beds of clays, sands and gravels of Pleistocene, or Tertiary age, with possibly Cretaceous below. Now the geologic beds on which Lonoke stands end to the west along the low foot hills that lie just west of the main line of the St. Louis, Iron Mountain, and Southern Railway. Along that line there is a complete change in the nature of the rocks and in the relations of the rocks to the water supply over Eastern Arkansas. If the relations of the two regions to each other were such as are shown in the cut below, the chances for getting a flow of water at Lonoke would be excellent.



Profile from west of Austin to Lonoke on the theory that Lonoke is lower than Austin.

But if the conditions are those suggested by the second illustration, if there is little or no eastward dip to the beds that



Profile from west of Austin to Lonoke, on the theory that the two places have the same elevation.

must necessarily carry the water, in other words if there is no "head" there can be no stream. But over such distances as that from the foot-hills to Lonoke, whether there is or is not an important difference of elevation, can be satisfactorily determined only by a line of levels. The levels along the Iron Mountain Railway when connected with the line along the Little Rock and Memphis Railway show that the country in question is so nearly flat that a free flowing well cannot be expected at Lonoke, while the structural geology suggests that at great depths a supply of good water may be had for the pumping. In other words the actual conditions are those shown in the second illustration. This conclusion is made possible by the lines of levels and without these levels it would not be possible to arrive at any satisfactory conclusion on this subject either for Lonoke or for any of the towns located in the ancient and immediate drainage basin of the Mississippi.

No doubt many other spirit level lines have been run in the state, but those given in the present volume are the only ones the Survey has found available. Some of the lines have been referred to an arbitrary datum and have never been tied to any point of known elevation and cannot therefore be given here. It will be noted that the railway elevations given are not the same in all cases as those furnished by the railways themselves. This is due to the fact that the line of precise levels carried across the state has enabled the Survey to refer most of the levels to mean tide with much greater precision. This has made it necessary to change the absolute elevations of the former somewhat; the relative elevations however remain unchanged.

It is hoped that future lines of levels will be based upon these, so far as may be practicable, and that the list of accurately determined elevations in the state may thus be greatly increased.

III. ELEVATIONS DETERMINED BY BAROMETER.

Elevations determined by means of the barometer are of value for all kinds of reconnoissance, and when these observations are checked by the use of a barometer stationed at some point whose elevation is determined by spirit level these measurements become available for the construction of topographic maps, if no great degree of accuracery is required.

It must be understood, however, that in all cases measurements by barometer should be based upon some established datum, and that their readings should be corrected for the diurnal and other variations to which they are subject.

In constructing topographic maps the Geological Survey has made use of the barometer, and the elevations of a large number of points have been determined in this way.

While the barometric elevations cannot be accepted as perfectly trustworthy, they serve to give an approximate idea of the relative elevations of many points over the state, and within rather wide limits these determinations may be regarded as correct. They will be found useful for purposes of reconnoissance, and topographic maps based upon them will often do away with preliminary surveys for roads and railways.

The United States Geological Survey in the course of its topographic survey, has made a large number of determinations of elevations by the use of the aneroid barometer. A list of the more important of the points measured has been kindly furnished by Mr. Henry Gannett, the chief topographer, and their elevations are given in the final list.

PRECISE LEVELS.

Locations, descriptions, and elevations of bench-marks on a line of precise levels between Arkansas City and Fort Smith, along the line of the Little Rock, Mississippi River and Texas Railway, and the Little Rock and Fort Smith Railway, determined by the United States Coast and Geodetic Survey.

List of the permanent bench-marks.

	Bench-mark.	Height above average level Gulf of Mexico in feet.	Page.
Arkansas City, Desha County	F	137.73	86
McGehee Station, Desha county	G	148.86	86
Tillar, Drew county	H	151.94	86
Walnut Lake, Desha county	I	162.65	86
Varner, Lincoln county	J	178.17	86
Noble Lake, Jefferson county	K.	201.49	87
Pine Bluff, Jefferson county, J. Bell's house	N.	223.32	87
Pine Bluff, Jefferson county, Normal School building	L	223.24	87
Near mile-post 85, south of Jefferson Springs, Jefferson county	E.	339.11	87
Redfield, Jefferson county	D.	306.59	88
Wrightsville, Pulaski county	C	256.85	88
Section House No. 2, Pulaski county	H	265.22	88
Little Rock, east face of the U. S. Custom House and Postoffice	A	297.85	88
Little Rock, U. S. Custom House and Post-office granite coping of the wall (see description)	B	296.54	89
Little Rock, stone to the west of and near the main entrance to the State House	O	287.06	89
Argenta, Pulaski county, West Base Monument, U. S. E	West Base	255.06	89
Four and a half miles from Little Rock on Little Rock and Fort Smith Railway	I	314.17	89
Marche, Pulaski county	II	267.57	89
Palarm, Faulkner county	III	268.79	90
Mayflower, Faulkner county	IV.	286.08	90
Preston, Faulkner county	V	274.63	91
Conway, Faulkner county	VI.	319.29	91
Section House No. 5 on L. R & F. S. Railway, Faulkner county	VII	329.42	91
Bridge over Cadron Creek	VIII.	282.59	91
Menifee, Conway county	IX	285.13	92
Plummerville, Conway county	X	290.34	92
Morrillton, Conway county	XI	386.03	92
Germantown, Conway county	XII	304.70	93
Blackville, Conway county	XIII	323.68	92

	Bench-mark.	Height above average level Gulf of Mexico in feet.	Page.
Atkins, Pope county	XIV	354.17	93
Galla Creek, Pope county	XV	369.54	93
Russellville, Pope county	XVI	348.56	94
Ouita Coal Company's store, near Ouita Station, Pope county	XVII	354.13	94
Railway bridge over Illinois Creek, Pope county	XVIII	325.79	94
Railway bridge over Mill Creek, Pope county	XIX	323.98	95
London, Pope county	XX	378.15	95
Railway bridge over Piney Creek, Johnson county	XXI	336.40	95
Knoxville, Johnson county	XXII	393.70	96
Cabin Creek, Johnson county	XXIII	409.04	96
Spadra Creek, Johnson county, railway crossing	XXIV	374.11	96
Clarksville, Johnson county	XXV	367.77	97
Clarksville, Johnson county	XXVI	366.52	97
Spadra, Johnson county	XXVII	376.12	97
Hartman, Johnson county	XXVIII	404.64	98
Coal Hill, Johnson county	XXIX	472.57	98
Altus, Franklin county	XXX	540.99	99
Ozark, Franklin county	XXXI	398.36	99
Poepping, Franklin county	XXXII	381.56	99
White Oak, Franklin county	XXXIII	394.88	99
Little Mulberry Creek, railway crossing, Franklin county	XXXIV	383.18	100
Dyer, Crawford county	XXXV	427.74	100
Alma, Crawford county	XXXVI	433.63	100
Van Buren, Crawford county	XXXVII	409.50	101
Van Buren, Crawford county	XXXVIII	412.97	101
Van Buren, Crawford county	XXXIX	412.94	101
Van Buren, Crawford county	XL	412.80	102
Fort Smith, Sebastian county	XLI	446.26	102
Fort Smith, Sebastian county	XLII	427.26	102

Descriptions of the permanent bench-marks.

Wilkerson's Landing, Miss.; (Bench-mark 84.) elevation 137.93 feet.

This is the United States permanent bench-mark of the Mississippi River Commission. (See report of the Mississippi River Commission for 1882, page 76.) It is the top of a brass bolt in a stone post on Mr. Rigby's plantation, 1400 meters below Wilkerson's Landing, Bolivar county, Mississippi. The stone is just outside of the fence, 15 paces back of levee and 10 paces northwest of the house occupied by Benjamin Cole. It is about six inches square, projects six inches above the surface of the ground, and has the letters U. S. carved on its upper surface.

Arkansas City, Desha county; (Bench-mark F.) elevation 137.73 feet.

The bottom of a square cavity cut in the top of an 8 by 8 inch granite post set in the ground about 2 meters south of the west corner of a small house which is occupied by the engineers of the Little Rock, Mississippi River and Texas Railway. This house is the first one southwest of the railway station. The letters U. S. B. M. are cut on the top of the stone.

McGehee Station, Desha county; (Bench-mark G.) elevation 148.86 feet.

The centre of the cross cut in the head of a copper bolt which is leaded, horizontally, into a brick of the chimney on the north side of a small whitewashed house, west of the line of the Little Rock, Mississippi River and Texas Railway. The brick is in the ninth course from the ground. The house may also be described as the first one south of the road crossing south of trestle No. 575, and the seventh one north of A. McGehee's store, used as the station and postoffice.

Tillar, Drew county; (Bench-mark H.) elevation 151 94 feet.
The centre of the cross cut on the head of a copper bolt leaded horizontally into a brick on the south side of the chimney at the back of H. L. Henry & Bro's. store. The brick is in the eleventh course from the ground and third one east of the side of the house.

Walnut Lake, Desha county: (Bench-mark I.) elevation 162.65 feet.

The centre of the cross cut on a 2½-inch copper bolt, leaded horizontally into a brick on the west side of the chimney on the north end of Mr. R. H. Pichen's dwelling house. The brick is in the eighteenth course from the ground.

Varner, Lincoln county; (Bench-mark J.) elevation 178.17 feet.
The bottom of a square cavity cut in top of granite post, set about two feet west of the extreme east corner of the front yard of R. R. Rice's residence. The house is a large white frame structure about 200 yards southeast of Varner Station. The bench is marked thus:

U. S.
B. M.

Noble Lake, Jeffersou county; (Bench-mark K.) elevation 201.49 feet.

The bottom of a square cavity cut in the top of a 6 by 6 inch granite post set at the southeast corner of the north extension of the platform of the Little Rock, Mississippi River & Texas Railway station. Marked thus:

U. S.
B. M.

Pine Bluff, Jefferson county; (Bench-mark N.) elevation 223.32 feet.

The bottom of a square cavity cut in the top of a 6 by 6 inch granite post, which is set in the front yard, at the southeast corner of a house belonging to Mr. John Bell. This house is at the intersection of Oak street and West Fourth Avenue, and is No. 803 on West Fourth Avenue. The top of the post is marked thus:

U. S.
B. M.

Pine Bluff, Jefferson county; (Bench-mark L.) elevation 223.24 feet.

Centre of cross cut on head of copper bolt, leaded horizontally into a brick on the south side of the State Branch Normal School. The brick is in the fourth course below the sill of the first window, east of the piazza. The school is situated just west of the city limits.

Near mile-post 85 of the Little Rock, Mississippi River and Texas Railway; (Bench-mark E.) elevation 339.11 feet.

The bottom of a square cavity cut in the top of a granite post set about six paces west of the track of the Little Rock, Mississippi River and Texas Railway, and about 23 paces south of the second telegraph pole, on the west side of the track, south of mile post 85. The post is dressed down to 6 by 6 inches, and its top marked thus:

U. S.
B. M.

Redfield, Jefferson county; (Bench-mark D.) elevation 306.59 feet.

The bottom of the square cavity cut in the top of a six by six inch granite post set in the northeast corner of a small front yard, between J. Converse's blacksmith shop and store. The post projects about four inches above the ground and its top is marked thus:

U. S.
B. M.

Wrightsville, Pulaski county; (Bench-mark C.) elevation 256.85 feet.

Bottom of square cavity cut in limestone block which is set in the ground near the southeast end of the platform at the Little Rock, Mississippi River and Texas Railway station. The stone is just west of the flight of stairs leading up to the platform from the south. The top is beveled and has the letters U. S. B. M. cut in the sides.

Wrightsville, Pulaski county; (Bench-mark H.) elevation 265 22 feet.

This is a secondary bench-mark between Sweet Home and Wrightsville. The bench is the top of a brass nail almost in the center of an equilateral triangle formed from three copper nails in the top of the southwest block which supports the platform, immediately in front of section house No. 2 of the Little Rock, Mississippi River and Texas Railway. This section house is between mile-posts 106 and 107, and is the one occupied by the section foreman.

Little Rock, Pulaski county; (Bench-mark A.) elevation 297.85 feet.

The center of a cross cut in the granite substructure of the east face of the United States Custom House and Post-office. It is beneath the water table course of masonry, and its center is about 13¾ inches north and about 5½ inches above the upper corner of the north line of the basement window, nearest Second street.

Little Rock, Pulaski county; same place as A; (Bench-mark B.) elevation 296.54 feet.

A rectangular cavity cut in the north side of the granite coping of the wall enclosing the small sunken area, immediately in front of the basement window referred to above. The bench is designated by the letters U. S. B. M.

Little Rock, Pulaski county; (Bench-mark O.) elevation 287.06 feet.

The bottom of a square cavity cut in the top of a 6 by 6 inch granite post, set near the main entrance of the State House. This post is about 29½ inches south and about 33½ inches west of the southwest corner of the stone porch.

Argenta, Pulaski county; (West Base) elevation 255.06 feet.

On the north bank of the Arkansas River in the east end of Argenta. A square cut on the extreme south end of the west monument of the United States Engineer's base line, and is marked with the letters U. S. B. M.

Little Rock and Fort Smith Railway; (Bench-mark I.) elevation 314.47 feet.

A granite post about 30 inches long and about 8 inches by 8 inches, rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 27 inches in the ground was used as this bench-mark. It is situated on the north side of the Little Rock and Fort Smith Railway between mile-posts 4 and 5 (from Little Rock), 4 paces from the track and 1.6 meters west of sixth telegraph pole west of trestle No. 12. The bottom of a square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows:

U. S.
□
B. M.

Marche, Pulaski county; (Bench-mark II.) elevation 267.57 feet.

A granite post about 30 inches long and about 8 inches by 8 inches, rough except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 27 inches in the ground was used as this bench-mark. It is situated in the southwest corner of

the yard in front of Mr. C. Chonoske's residence at Marche, Pulaski county, (Little Rock and Fort Smith Railway). This house joins the store and post-office. The bottom of a square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows :

U. S.

B. M.

Palarm, Faulkner county; (Bench-mark III.) elevation 268.79 feet.

A granite post about 24 inches long, and about 8 inches by 8 inches, rough except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 21 inches in the ground was used as this bench-mark. It is situated on the west end of the yard owned by Daniel Chism, post-master at Palarm, Faulkner county, Ark , and is close to the line of fence about 10 meters north of the building containing the post-office. It is also on the line with the south end of the platform of the railway station at Palarm. Four lines forming a rough square were cut on top of the post as its center, and the surface within this square is the bench-mark. The top of the post is marked as follows :

U. S.

B. M.

Mayflower, Faulkner county; (Bench-mark IV.) elevation 286.08 feet.

A granite post about 30 inches long and about 8 inches by 8 inches, except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 27 inches in the ground, was used as this bench mark. It is situated in the southwest corner of the yard in front of a house belonging to Mr. J. R. Miller at Mayflower, Faulkner county, (Little Rock and Fort Smith Railway). This house is almost due east of the station. Four lines were cut on the top of the post, forming a rough square at its center, and the surface within this square is the bench-mark. The top of the post is marked as follows :

U. S.

B. M.

Preston, Faulkner county; (Bench-mark V.) elevation 274.63 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 27 inches in the ground, was used as this bench-mark. It is situated in the west end of the yard owned by J. W. Austin at Preston, close to the line of the fence and on the line with the north end of the building containing the postoffice and store. The bottom of a square hole cut in the top of the post is the bench-mark. The top is marked as follows:

U. S.

B. M.

Conway, Faulkner county; (Bench-mark VI.) elevation 319.29 feet.

This is situated on top of the stone foundation at the south-west corner of the brick record vault of the court house at Conway. It consists of a square hole cut in a flat stone of the foundation. The bottom of the hole is the bench mark. It is marked as follows: U. S. B. M. The letters are roughly cut by an unskillful stone cutter.

Section House No. 5, Faulkner county; (Bench-mark VII.) elevation 329.42 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 26 inches in the ground, was used as this bench-mark. It is near the fence to the yard in front of the house where the railway section hands live, and is nearly opposite Section House No. 5, of the Little Rock and Fort Smith Railway. The bottom of a square hole cut in the top of the post is the bench-mark. The top is marked as follows:

U. S.

B. M.

Bridge over Cadron Creek, Faulkner county; (Bench-mark VIII.) elevation 282.59 feet.

A square hole was cut in the top of the stone abutment to the railway bridge over Cadron Creek on the Little Rock and Fort Smith Railway, and the center of the bottom of this hole is the bench-mark. It is situated on the abutment on the east bank of the creek and north of the track. It is marked as follows, the letters being roughly cut in the soft sandstone:

U. S. — B. M.

Menifee, Conway county; (Bench-mark IX.) elevation 285.13 feet.

A granite post about 30 inches long and about 8 inches by by 8 inches, except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 27 inches in the ground, was used as this bench-mark. It is situated at Menifee, Conway county, a few feet west of the store-house used as a postoffice, and is in line with the front of this building. An old well is quite near the store. The bottom of a square hole cut in the top of this post is the bench-mark. The top of the post is marked as follows:

U. S.

B. M.

Plummerville, Conway county; (Bench-mark X.) elevation 290.34 feet.

A granite post 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 25 inches in the ground, was used as this bench-mark. It is situated in the southeast corner of the yard to the Sims Hotel at Plummerville. The bottom of a square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows:

U. S.

B. M.

Morrillton, Conway county; (Bench-mark XI.) elevation 386.03 feet.

A square hole was cut in the top of the upper step (stone) to the west entrance of the Court House at Morrillton, Conway county. The bottom of this hole which is near the south end of the step is the bench-mark. It is marked as follows:

U. S.
□
B. M.

Germantown, Conway county; (Bench-mark XII.) elevation 304.70 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, was used as a bench-mark. It is situated in the southeast corner of the yard to the Little Rock and Fort Smith Railway Section House No. 7 at Germantown. The bottom of a square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows:

U. S.
□
B. M.

Blackville, Conway county; (Bench-mark XIII.) elevation 323.68 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 24 inches in the ground was used as this bench-mark. It is situated in the southeast corner of the yard of W. H. Jones' house at Blackville. The bottom of a square hole cut in the top of this stone is the bench-mark. The top of the post is marked as follows:

U. S.
□
B. M.

Atkins, Pope county; (Bench-mark XIV.) elevation 354.17 feet.

A square hole was cut in the southwest corner of the stone door sill at the southwest corner of the brick building owned by E. A. Darr at Atkins. The building is at the northeast corner of Railroad Avenue and Dover street. The bottom of the hole is the bench-mark. The stone is marked as follows:

U. S.
□
B. M.

Galla Creek, Pope county; (Bench-mark XV.) elevation 369.54 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 24 inches in the ground, was used as this bench-mark. It is situated in the northeast corner of the yard to the large frame house owned by J. Potts and J. H. Ragsdale at Galla Creek. The bottom of a square hole cut in the top of the post is the bench-mark. The bottom is not even and the rod was held at the lowest point which is slightly below the general surface of the bottom. The top of the post is marked as follows:

U. S.

B. M.

Russellville, Pope county; (Bench-mark XVI.) elevation 348.56 feet.

A square hole cut in the stone foundation to the main entrance of the Court House at Russellville; the bottom of the hole is the bench-mark. It is on the right of the entrance going into the building and it is marked as follows:

U. S.

B. M.

Ouita, Pope county; (Bench-mark XVII.) elevation 354.13 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top, which is dressed to 6 inches by 6 inches, buried 20 inches in the ground, was used as this bench-mark. It is situated in the southwest corner of the yard to the dwelling attached to the Ouita Coal Company's store near Ouita station, Pope county. The bottom of the square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows:

U. S.

B. M.

Bridge over Illinois Creek, Pope county; (Bench-mark XVIII.) elevation 325.79 feet.

A square hole was cut in the top of the stone abutment to the Little Rock and Fort Smith Railway bridge over Illinois

Creek for this bench-mark. It is an abutment on the west side of the creek and is north of the track. Tne bottom of the hole is the bench-mark. It is marked as follows, the letters being roughly cut:

U. S.
B. M.

Bridge over Mill Creek, Pope county; (Bench-mark XIX.) elevation 323.98 feet.

A square hole was cut in the top of the stone abutment to the Little Rock and Fort Smith Railway bridge over Mill Creek, near Mill Creek Station for this bench-mark. It is on the abutment on the west side of the creek, and is north of the track. The bottom of the hole is the bench-mark. It is marked as follows, the letters being roughly cut:

U. S.
□
B. M.

London, Pope county; (Bench-mark XX.) elevation 378.15 feet.

A granite post about 30 inches long and about 8 inches by 8 inches rough, except 6 inches of the top which is dressed to 6 inches by 6 inches, buried 24 inches in the ground, was used as this bench-mark. It is situated in the northeast corner of the yard to Mrs. Sarah Battenfield's house at London, Pope county. The bottom of a square hole cut in the top of the post is the bench-mark. The top of the post is marked as follows:

U. S.
□
B. M.

Little Rock and Fort Smith Railway bridge over Piney Creek, Johnson county; (Bench-mark XXI.) elevation 336.40.

A square hole about a half inch deep was cut in the upper surface of the stone forming the top of the stone pier of the Little Rock and Fort Smith Railway bridge over Piney Creek as this bench-mark. It is north of the track and on the pier on the east side of the creek. The bottom of the square hole is the bench-mark. It was roughly marked as follows:

U. S.

B. M.

This bridge is about one-fourth of a mile west of Berlin Post-office (Piney Station) on the Little Rock and Fort Smith Railway.

Knoxville, Johnson county; (Bench-mark XXII.) elevation 393.70 feet.

A cross was cut in one of the stones forming the foundation to the chimney on the west side of Dr. R. M. Osborn's residence at Knoxville, as this bench-mark. The center of the cross is 1 foot $10\frac{1}{2}$ inches above the ground and $10\frac{1}{3}$ inches from the outside face of the chimney, and it is on the side next to the railroad on which the house fronts. The house is a small frame structure and is west of the railway station near the track. The stone is roughly marked as follows:

U. S.

B. M.

and the intersection of the lines forming the cross is the bench-mark.

Cabin Creek, Johnson county; (Bench-mark XXIII.) elevation 409.04 feet.

A copper bolt was leaded in the south face of the brick chimney on the west side of the City Hotel at Lamar (Cabin Creek), for this bench-mark. The bolt is in the third row of bricks from the ground and in the second brick from the outside face of the chimney. A cross was cut in the end of the bolt, and the intersection of the lines forming this cross is the bench-mark. The house is one of the oldest in the town, according to information furnished by a bystander.

Spadra Creek, Johnson county; (Bench-mark XXIV.) elevation 374.11 feet.

A square hole was cut in the top of a stone pier to the Little Rock and Fort Smith Railway bridge over Spadra Creek, near Clarksville, for this bench-mark. The pier is on the west bank of this creek and the bench-mark is north of the track, near the

western face of the pier. The bottom of this hole is the bench-mark. It is roughly marked as follows:

U. S.
□
B. M.

Clarksville, Johnson county; (Bench-mark XXV.) elevation 367.77 feet.

The north monument of the meridian line established in the Court house yard at Clarksville, by the officers of the State Geological Survey, was used as this bench-mark. This monument is a stone roughly dressed at the top to 6 inches by 6 inches for 6 inches below the top, planted in the northeast corner of the Court House yard. It has a hole in the center of the top filled with lead into which a small brass pin is driven; the top of this pin is the bench-mark. The top of the lead is even with the upper surface of the stone and the stone seems firmly set in position.

Clarksville, Johnson county; (Bench-mark XXVI.) elevation 366.52 feet.

The south monument of the meridian line established in the Court House yard at Clarksville was used as this bench-mark. This monument is a stone roughly dressed at the top to 6 inches by 6 inches below the upper surface, planted near the southeast corner of the court house yard, just outside of the iron fence. It has a hole in the center of the top filled with lead, into which a small brass pin is driven, and the top of this pin is the bench-mark. The top of the lead is about even with the upper surface of the stone and the stone seems firmly fixed in position.

Spadra, Johnson county; (Bench-mark XXVII.) elevation 376.12 feet.

A stone post roughly dressed to 6 inches by 6 inches for 6 inches below the top, and 2½ feet long was used as this bench-mark. This stone is planted 2 feet in the ground in the southeast corner of the yard to J. Siegel's store at Spadra, Johnson county. It is 22 meters east of the store, about 50 meters north of the railway, and 150 meters east of the railway station

The bottom of a square hole cut in the top of the stone is the bench-mark.

The stone post was made by a local stone cutter at Clarksville, and the work is very roughly done, the letter S being cut backwards. It is marked as follows:

U. S.
□
B. M.

1889 is cut on one face.

Hartman, Johnson county; (Bench-mark XXVIII.) elevation 404.64 feet.

A cross was cut on the stone chimney on the east end of the house owned by John Durnham at Hartman, Johnson county, for this bench-mark. The house is about one-third of a mile west of the railway station, and the cross is on the south side of the chimney or side facing the railway, and is on the fourth stone from from the ground. The house stands about 150 meters north of the railway, and the cross and letters are roughly cut, as follows:

U. S.
+
B. M.

The intersection of the lines forming the cross is the bench-mark.

Coal Hill, Johnson county; (Bench-mark XXIX.) elevation 472.57 feet.

A square hole was cut in the stone foundation of the stone chimney to the kitchen of the Central Hotel at Coal Hill for this bench-mark. The hotel is quite near the railway station, and the kitchen is behind the main building and built as an extension to it. The bench-mark is about the center of the outer face of the chimney, which is on the east side of the chimney. It is roughly lettered as follows:

U. S.
⊔
B. M.

The bench mark is about 3 inches above the ground, and the bottom of the hole is the bench-mark.

Altus, Franklin county; (Bench-mark XXX.) elevation 540.99 feet.

A copper bolt was leaded in the south side of the brick chimney of the large boarding house near the railway station at Altus for this bench-mark. The house is owned by F. M. Hammond, and is situated north of the track and a short distance west of the railway station. The bolt is in the eighth course from the stone foundation and the third brick from the east side of the chimney. The intersection of the lines cut in the end of the bolt forming a cross is the bench-mark, which is in the center of the end of the bolt. It was roughly lettered as follows:

U. S.
+
B. M.

Ozark, Franklin county; (Bench-mark XXXI.) elevation 398.36 feet.

A copper bolt was leaded in the east side of the brick court house (near the southeast corner) at Ozark, for this bench-mark. The bolt is in the row above the ground and in the brick from the southeast corner. A cross was cut in the end of the bolt and the intersection of the lines forming the cross is the bench-mark. It is not lettered, as no stone cutter was at hand, and it was not desired to deface the building.

Poepping, Franklin county; (Bench-mark XXXII.) elevation 381.56 feet.

A small hole was roughly cut in the stone foundation to the stone chimney on the east end of the J. H. Bronte's house at Poepping, Franklin county, for this bench mark. This is the only house at the station, which is nothing more than a switch. The bench-mark is only a few inches above the ground and is at the northwest corner of the chimney. No tools were at hand, and the hole was cut with a railway spike. The bottom of the hole is in the bench-mark.

White Oak, Franklin county; (Bench-mark XXXIII.) elevation 394.88 feet.

A square hole was cut about half an inch deep in the stone

foundation to the chimney on the east end of Dr. W. W. Rambo's house at White Oak, Franklin county, for this bench-mark. The house is about 20 meters north of the railway and is a short distance west of the station sign. The office is in the corner of the yard near the house. The bottom of the hole is the bench-mark. It is roughly marked as follows:

U. S.
B. M.

The bench-mark is only a few inches above the ground.

Little Mulberry Creek, railway crossing, Franklin county; (Bench-mark XXXIV.) elevation 383.18 feet.

A square hole was cut in the top of the stone pier to Little Rock and Fort Smith Railway bridge over Little Mulberry Creek for the bench-mark. It is on the pier of the east bank of the creek and is south of the track inside the outer line of the superstructure of the bridge. The bridge is one-third of a mile west of the railway station at Mulberry. The bottom of the hole is the bench-mark. It is roughly marked as follows:

U. S.
B. M.

Dyer, Crawford county; (Bench-mark XXXV.) elevation 427.74 feet.

A square hole was cut in the stone foundation to the stone chimney on the east side of a house belonging to W. W. Larne at Dyer for this bench-mark. The stone is quite rough and no attempt was made to cut letters. The bench-mark is only a few inches above the ground. The house is opposite the cotton platform at this station, and is north of the track and about 80 meters or yards distant. The bottom of the hole is the bench-mark.

Alma, Crawford county; (Bench-mark XXXVI.) elevation 433.63 feet.

A copper or brass bolt (one-half inch in diameter) was leaded in the north wall of a brick store at Alma (belonging to Mr. L. C. Locke), for this bench-mark. The bolt is in the fifth brick from the northeast corner of the building and in the seven-

teenth course from the foundation. A cross was cut in the end of the bolt and the intersection of the lines forming this cross is the bench-mark. The building is opposite the railway station and directly south of it. There are no buildings between the railway station and this store.

Van Buren, Crawford county; (Bench-mark XXXVII.) elevation 409.50 feet.

A stone post 2½ feet long, roughly dressed to 6 inches by 6 inches at the top and for six inches below it, was used as this bench-mark. It was buried 20 inches in the ground in the south corner of the Court House yard at Van Buren. A square hole was cut in the top of the post and the bottom of this hole is the bench-mark. It was roughly lettered as follows:

U. S.
□
B. M.

1889 is roughly cut on one side of the post.

Van Buren, Crawford county; (Bench-mark XXXVIII.) elevation 412.97 feet.

A copper bolt was leaded in the southwest wall of the brick CourtHouse at Van Buren, for this bench-mark. The bolt is in the second course from the foundation and in the second brick from the south corner of the building. A cross was cut in the end of the bolt and the intersection of the lines forming the cross is the bench-mark. The brick cracked when the bolt was driven in and it should be compared with bench-mark XXXVII, which is only a few feet distant, before being used.

Van Buren, Crawford county; (Bench-mark XXXIX.) elevation 412.94 feet.

A square hole was cut in the stone abutment to the iron railway bridge over the Arkansas River at Van Buren, for this bench mark. It is east of the track and on that portion of the abutment on which the bridge rests on the north bank of the river. The bottom of the hole is the bench-mark. It is marked as follows:

U. S.
□
B. M.

Van Buren, Crawford county; (Bench-mark XL.) elevation 412.80 feet.

A square hole was cut in the stone abutment to the iron railway bridge over the Arkansas River at Van Buren for this bench-mark. It is on that portion of the abutment on which the end of the bridge rests on the south bank of the river. The bottom of the hole is the bench-mark. It is marked as follows:

U. S.
[ ]
B. M.

B. M. XL.

Fort Smith, Sebastian county; (Bench-mark XLI.) elevation 446.26 feet.

A copper bolt was leaded in the west wall of the United States brick jail for this bench-mark. The bolt is in the first course above the limestone base stone, about 1 meter above the ground. It is in the fifth brick from the jamb formed by the side of the building and the brick ventilator. The jail is a new pressed brick addition, with stone trimmings, to the old United States building. A cross was cut in the end of the bolt and the intersection of the lines forming the cross is the bench-mark. The letters U. S. B. M. were cut in the base stone immediately below the bolt.

Fort Smith, Sebastian county; (Bench-mark XLII.) elevation 427.26 feet.

A square hole was cut in the outer edge of the stone door sill to the back door of the brick building on the northeast corner of Garrison Avenue and First street, at Fort Smith for this bench-mark. The building is owned by Mr. Thomas Rogers and used as a saloon. It is diagonally across the street from the old Little Rock and Fort Smith Railway passenger station. The bottom of the hole is the bench-mark. The letters U. S. B. M. were cut immediately below the hole in the door sill.

RAILWAY OR SPIRIT LEVELS.

The elevations given below are those furnished by lines of spirit levels run for purposes of reconnoissance or construction of railways. In the cases of railways constructed the elevations, unless otherwise stated, refer to the top of the nigh rail at the passenger station.

Many of the railway lines were run from assumed data; in all such cases the lines have been tied and adjusted to the line of precise levels brought up for this Survey from the Gulf of Mexico by the United States Coast and Geodetic Survey. The elevations given herewith therefore having been thus adjusted will not be found to agree exactly with those kept on file in the offices of the engineers of the several railways.

The elevations along the various railway lines in the State vary greatly in accuracy and value; and some of them have been found so at variance with the system as a whole, that it has not been possible to use them in this list.

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(Main Line.)

Stations.	Elevations.
Moark	297.10
Corning	289.10
Colony Lake	282.60
Black River	288.10
Knobel	280.10
Peach Orchard	285.10
Delaplaine	277.60
O'Kean	270.60
Murtha	270.60
Walnut Ridge	270.10
Hoxie	268.10
Minturn	260.60
Alicia	253.60
Swifton	248.00
Tuckerman	241.60
Diaz (Junction Batesville Branch)	230.10
Newport	227.10*

*The track has been raised at Newport; it is not known how much. Levels from the U. S. Bench-mark on the river bank 400 feet north of the elevator make the top of rail opposite south end of passenger station 233.07.

Stations.	Elevations.
White River bridge	232.70
Olyphant	220.10
Grand Glaise	223.10
Bradford	241.10
Russell	233.10
Bald Knob	220.10
Judsonia	217.10
Little Red River	217.10
Kensett	224.10
Higginson	220.10
Garner	220.60
Beebe	244.60
Ward	238.10
Austin	248.10
Cabot	288.10
Holland	255.10
Jacksonville	282.10
McAlmont	271.10
Baring Cross	260.10
Arkansas River bridge	267.10
Little Rock	259.10
Ensign	295.10
Mabelvale	308.10
Alexander	325.10
Bryant	357.10
Benton	297.10
Saline River bridge	284.10
Traskwood	288.10
Gifford	331.10
Malvern	273.10
Etta	243.10
Donaldson	228.10
Witherspoon	199.10
Ouachita River bridge	196.10
Arkadelphia	186.10
Curtis	186 10
Smithton	205.60
Gurdon	208.10
Bierne	222.10
Boughton	233.10
Prescott	323.10
Emmet	294.67
Hope	352.10
Sheppard	280.10
Fulton	259.10
Red River bridge	267.10
Homan	266.10
Mandeville	314.10
Texarkana	298.10

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Crowley's Ridge Branch.*)

Stations.	Elevations.
Knobel	280.10
Cache	290.10
Gainesville	336.00
Paragould	282.20
Bethel	284.10
Powell	264.60
Nettleton*	253.10
Ridge	283.10
Harrisburg	284.10
White Hall	276.60
Cherry Valley	284.60
Vanndale	278.60
Wynne	249.90
Forrest City (west rail at crossing of L. R. & M. Ry)	278.16
Bonair	230.90
Hicks	224.90
Haynes	222.90
Canaan	225.40
L'Anguille River	203.90
Felton	219.80
Marianna	235.70
Preston	220 70
LaGrange	207.90
Howe	207.10
Lexa	209.40
Latour	202.70
Huma	196.90
Arkansas Midland Ry. crossing	202.90
Helena	193.40

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Batesville Branch.*)

Stations.	Elevations.
Diaz	230.10
Paroquet	235.80
Newark	239.70
Sulphur Rock	308.60
Moorefield	310.10
Batesville	268.10
James	416.10
Cushman	707.10

*Nettleton: The Crowley Ridge Branch elevations have been corrected by K. C., S. & M. levels at Nettleton, there being a discrepancy between the Bald Knob levels at Wynne and the K. C., S. & M. The Bald Knob levels agree within 4-10 of a foot at West Memphis.

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Bald Knob Branch.*)

Stations.	Elevations.
Glaize Creek	208.40
Rio Vista	208.40
White River (high-water mark)	206.40
White River (low-water mark)	179.40
Augusta	211.10
Krums' Mill	196.40
Fakes	200.40
West bank Cache River	198.40
Martin (crossing of White and Black River Valley Railway)	201.40
McCrory	209.40
Bayou DeView	207.10
Morton	223.40
First Creek	217.90
Hamlin	220.80
Wynne Junction	249.90
Summit Crowley's Ridge	342.00
Levesque	229.10
St. Francis River bridge	224.10
Parkin	222.10
Earl	222.60
Crawfordville	221.10
Elmo	226.10
Gavin	221.10
West Memphis	220.70

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Camden Branch.*)

Stations.	Elevations.
Whelen	248.60
Sayre	204.10
Chidester	230.90
Camden	143.10

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Warren Branch.*)

Stations.	Elevations.
Arkansas City	137 30
Trippe Junction	141.90
Halley	137.30
Dermott	140.90
Bayou Bartholomew bridge	138.00
Baxter	139.50
Collins	167.40
Monticello	271.40
Allis	193.10
Wilmar	147.60
Saline	123.60
Warren	204.70

HOUSTON, CENTRAL ARKANSAS AND NORTHERN RAILROAD.

Stations.	Elevations.
McGehee	146.00
McGehee Junction	145 08
Dermott	140 88
Hudspeth	134.70
Morrell	132.97
Portland	128.15
Parkdale	118.55
Wilmot	115.95
Cypress	110.72
State Line, Arkansas and Louisiana	108.80

ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY.

(*Little Rock and Fort Smith Branch.*)

Stations.	Elevations.
Argenta (Little Rock and Memphis crossing)	261.4
Fort Smith crossing	257.0
Marche	267.0
Reynolds Spur	281.0
Palarm	268 8
Mayflower	285.5
Gold Creek	294 1
Preston	270.7
Conway	308.6
Alpine	426 0
Menifee	285.5
Plummerville	285.6
Morrillton	377.2
Welborne	314.4
Point Remove	299.1
Germantown	302.9
Blackville	327.4
Atkins	353.5
Galla Creek	358.6
Russellville	338.2
Ouita	354.7
Mill Creek	380.4
London	371.9
Mixer	358.3
Piney	345.5
Knoxville	393.2
Turner	390.4
Cabin Creek	404.1
Clarksville	365.1
Spadra	378.0
Montana	388 9
Hartman	363.9
Coal Hill	468 0
Felker	498.9
Altus	535.2
Ozark	376.6

Stations.	Elevations.
[illegible]	[illegible]
White Oak	[illegible]
Pleasant Valley	[illegible]
Mulberry	[illegible]
Dyer	[illegible]
Alma	[illegible]
Van Buren	[illegible]
St. L. & S. F. Junction	[illegible]
Ft. Smith	[illegible]

KANSAS CITY, SPRINGFIELD AND MEMPHIS RAILWAY.

Stations.	Elevations
Mammoth Springs	512 10
Afton	[illegible]
Hardy	[illegible]
Williford	319 10
Ravenden	[illegible]
Spring River bridge	[illegible]
Imboden	[illegible]
Black Rock	[illegible]
Black River bridge	[illegible]
Portia	252.10
Hoxie	[illegible]
Sedgwick	[illegible]
Bonnerville	264.10
Jonesboro	309 10
Cotton Belt Railway crossing	269 10
Nettleton	[illegible]
Big Bay Siding	242.10
Hatchie Coon	230.10
St. Francis River bridge	234 10
Marked Tree	229.10
Tyronza River bridge	232.10
Tyronza	229.10
Gilmore	229.10
Clarketon	229.10
Marion	225.10
I. R. & M. Ry. crossing	221.10
West Memphis	221 10
Zero of river guage at Memphis	185 60
West Memphis Bald Knob Branch levels	2207 0

LINE OF LEVELS FOR A RAILWAY FROM THE MOUTH OF BULL CREEK, MO., TO DARDANELLE, ARK.

Corrected by approximate comparison with Coast Survey levels at Russellville, Ark.

Stations.	Sec.	Town.	Range.	Elevations.
Arkansas state line near headwaters of Turkey Creek	10	21 N.	21 W.	[illegible]
Omaha	22	21 N.	21 W.	1878.0
Burlington	20	21 N.	21 W.	[illegible]
Summit south of Bear Spring	30	19 N.	20 W.	1310.0

Stations.	Sec.	Town.	Range.	Elevations.
Valley east of Harrison	3	18 N.	20 W.	1100.0
Valley west of Bellefonte	19	18 N.	19 W.	1036.0
Summit at head of Elm Branch of Hog Creek	32	18 N.	19 W.	1200.0
Flats of Clear Fork and Hog Creek at Marshall Branch	5	17 N.	18 W.	848.0
Summit Clear and Mill Creeks	10	16 N.	18 W.	1173.0
Summit Mill and Dry Creeks	16	16 N.	17 W.	800.0
Farm Flats above overflow	31	16 N.	16 W.	583.0
Bear Creek Valley 2½ miles below summit	.....	.....	.....	1156.0
Summit of Bear Creek and Middle Fork of Illinois Creek	19	13 N.	17 W.	1853.0
Junction East and Middle Forks Illinois Creek. Farm lands above overflow	7	10 N.	18 W.	628.0
Junction North Fork Illinois Creek	21	10 N.	19 W.	483.0
Second Bench at Dover	21	9 N.	20 W.	448.0
Intersection L. R. and Ft. S. Ry. at Russellville	5	7 N.	20 W.	340.0
Arkansas River Flats opposite Dardanelle	19	7 N.	20 W.	314.0

ST. LOUIS SOUTHWESTERN RAILWAY.

"Cotton Belt."

Connection made with Coast Survey levels by means of St. L., I. M. and S., and K. C., S. and M. Ry. levels at Jonesboro and Paragould.

(From Jonesboro to Mo. State Line.)

Stations.	Elevations.
Jonesboro	311.10
Brookland	261.50
Bethel	280.50
Paragould	280.31
Marmaduke	271.50
Rector	287.50
Greenway	289.50
Piggott	286.50
St. Francis	294.50

(From Pine Bluff to Aurich Junction.)

Pine Bluff	211.58
Wilkins	208.58
Rob Roy	208.58
Altheimer	207.58
Wabbaseca	204.58
Humphreys	186.58
Goldman	198.58
Stuttgart	210.58
Parham	217.58
Aurich	208.58
Aurich in L. R. and M. R. Ry. levels	205.58

The difference of 3 feet at Aurich may be caused by a change in reference plane of levels. It was deemed best to carry elevations direct from the Coast Survey Bench-mark in Pine Bluff.

(*Altheimer Branch.*)

Stations.	Elevations.
Argenta (St. L., I. M. & S. Ry. Junction)	252 7
Argenta (L. R. & M. Ry. Junction)	255.2
Baucum	249 8
Scotts	249.8
Toltec	236.8
England	228 8
Tucker	224 8
Sherrill	216 8
Altheimer	206.2

MISSISSIPPI AND LITTLE ROCK RAILWAY.

"Wat Worthen's Road."

Stations.	Elevations.
White River (west bank)	181.62
White River (high water)	169.86
Bayou LaGrue	191.62
Aurich (crossing of Cotton Belt Ry.)	207.68
Grand Prairie (highest point)	224.62
Fairmount	221.62
Bayou Two Prairie	194 12
Bayou Meto	201.62
Crooked Creek	205 62
Baker's Bayou	220.62
Indian Bayou	221.62
Ashley's Bayou	241.62
Lowry Bayou	247.62
Little Rock & Memphis Ry. crossing	253.62
Middle east side sec. 35, 2 N., 12 W	254.62

LITTLE ROCK AND MISSISSIPPI RIVER RAILWAY.

Stations.	Elevations.
Aberdeen	184.18
(Approximate)	175.68
Aurich (crossing of Cotton Belt Ry.)	205.58
Bayou LaGrue bridge	193.48
Crossing Beebe, Stuttgart and Arkansas River Ry	220.08
Fairmount	222.68
Clear Point Ridge	224.68
Belcher	203.68
Ray	202.68
Bayou Meto bridge	201.88
Bottom of Bayou Meto	182 98
Seatonville	207.68
Crooked Bayou Bridge	205.68
Ross	223.68
Head	227 18
Stainer	237.68
Bearskin	242.68
Ashley Bayou bridge	241.68
Jones Bayou	243 68

Stations.	Elevations.
Faulkner's Lake	250.68
Crossing L. R. & M. Ry	253.68
Argenta	254.68

Elevations given are based on St. Louis, Mo., City Directrix, being 414.4 feet above sea level.

ST. LOUIS AND SAN FRANCISCO RAILWAY.

Stations.	Elevations.
Seligman, Missouri	1541.4
Garfield	1519.4
Brightwater (at Platform)	1270.4
Brightwater, Sugar Creek (natural surface)	1216.4
Avoca	1361.4
Rogers	1385.4
Lowell	1346.4
Springdale	1325 4
Johnsons	1194.4
Fayetteville	1340.4
Greenland	1250.4
West Fork	1340.4
Woolsey	1377.4
Brentwood	1484.4
Winslow	1735.4
Summit Home (surface of ground above tunnel)	1887.4
Porter	1092.4
Chester	840.4
Mountainburgh	714.4
Lancaster	623.4
Rudy	498.4
Lillie	452.4
Van Buren	439.4
Fort Smith	419.4

(Bentonville Railway.)

Rogers	1385.4
Bentonville	1302.4

(St. Paul Branch.)

Fayetteville	1340.4
Fayette Junction	1243.4
Baldwin	1236.4
Harris	1201.4
Elkins	1221.4
Durham	1247.4
Thompson	1281 4
Crosses	1338.4
Delaney	1361.4
Powell	1362.4
Combs	1406.4
St. Paul	1500.4

Mansfield Branch.

Stations.	Elevations.
Jenson	542.4
Hackett	[illegible]
Montreal	[illegible]
Huntington	[illegible]
Mansfield	[illegible]

EUREKA SPRINGS RAILWAY.

Stations.	Elevations.
Seligman, Missouri	1542.4
Wa[illegible]	[illegible]
The Narrows	934.4
Beaver	[illegible]
Leatherwood	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Eureka Springs (depot in the valley)	[illegible]
Eureka Springs (Crescent Hotel)	[illegible]
Eureka Springs (Pond Mountain)	[illegible]

KEARNEY, JEFFERSON CO., TO SHERIDAN, GRANT CO.

Points on a line surveyed from Kearney, Jefferson county, to Sheridan, Grant county, Ark. Elevations corrected by comparison with United States Coast Survey levels at Kearney. Records furnished by John J. Martin, C. E., Pine Bluff, Arkansas.

Stations.	Elevations.	Locations.
Summit	[illegible]	S. W. of S. W. sec. [illegible], 4 S., 12 W.
Bottom of Brushy Creek	240.1[illegible]	N. E. of S. E. of sec. [illegible]6, 4 S., 12 W.
" Little Brushy Creek	[illegible]	N. E. of N. E. of sec. [illegible], 4 S., 12 W.
" Ashley's Creek	[illegible]	S. E. of S. E. of sec. [illegible], 4 S., 12 W.
" Hurricane Creek	[illegible]	Near N. line of sec. 6, 5 S., 12 W.
" Big Creek	[illegible]	
Sheridan (outskirts of town)	[illegible]	
Sheridan (main part of town), about	[illegible]	

LITTLE ROCK AND MEMPHIS RAILWAY.

Stations.	Elevations.
Argenta	[illegible]
Devall's Bluff	[illegible]
Devall's Bluff (high water in White River [illegible])	[illegible]
[illegible]	[illegible]
Goodwin	[illegible]
Palestine	2[illegible]1.40
Forrest City	27[illegible]
St. Francis River bridge	[illegible]
Bottom of St. Francis River	18[illegible]

ARKANSAS AND LOUISIANA RAILWAY.

Stations.	Elevations.
Hope	352 10
Washington	354.10
Bridge, South Fork of Ozan	317.10
Ozan	356.10
Nashville	352.10

LITTLE ROCK AND CHOCTAW RAILWAY SURVEY.

Approximate connection with Iron Mountain Railway levels at Little Rock.

Stations.	Elevations.
Summit, Head of Rankin's Creek	780.00
Perryville	290.00
Waldron, Crossing of Main Street	660.00
Bottom of Poteau River	604.00
Indian Territory line	626.00

ULTIMA THULE, ARKADELPHIA AND MISSISSIPPI RIVER RAILWAY SURVEY FROM ARKADELPHIA TO WARREN.

Stations.	Elevations.	Locations.
Daleville	182.40	
Dalark (approximate)	242 50	
Cypress Creek (high water)	218 00	S. W. of N. W. of sec. 12, 8 S., 17 W.
Bottom of West Tulip Greek	231.40	Near center of sec. 10, 8 S., 16 W.
Bottom of East Tulip Creek	232.50	S. W. of S. W. of sec. 27, 8 S., 15 W.
Princeton	244.00	
Backbone Ridge two to four miles south of Princeton	341.00	Sections 11 and 14, 9 S., 15 W.
Cotton Belt Railway Crossing about 50 feet north or depot at Fordyce	259 46	
Bottom Moro Creek	141.46	
Bottom L'Aigle Creek	198.50	
Warren Branch 1 mile west of Warren	260.46	Divide near S. W. cor. sec. 29, 10 S, 10 W.
Warren Branch 4 miles west of Warren	252.95	End of old track.

NOTE.—This last elevation is the U. T., A. & M. R. Ry. levels connected with end of 22 mile extension from Monticello, and is about 4 miles west of Warren.

LIST OF ELEVATIONS OF THE CITIES, TOWNS, POST-OFFICES, AND OTHER POINTS IN THE STATE OF ARKANSAS.

In the following table all the elevations known to have been determined in the State of Arkansas are brought together and referred to mean tide level on the Gulf of Mexico. Elevations marked "precise" were determined by the United States Coast and Geodetic Survey and are as accurate as they can be made (the bench-marks are described in the preceding list of precise levels, pages 85 to 102); those marked "spirit level" have been made with the Y level generally used in making railway surveys. Those marked "barometer" were determined with a mercurial barometer by the United States Geological Survey; those marked "aneroid" were determined by the use of aneroid barometers; the last are not to be depended on when great accuracy is required. When a place is known by two different names that of the post-office is given first, the other name follows in parenthesis.

This list includes all the post-offices and railway stations of the state up to 1893, even though in many cases the elevations of the places are not known. The complete list of places will enable its users to fill in the missing elevations as they become known. Confusion in elevations is sometimes caused by the removal of country post-offices from one house to another.

Place.	County.	Elevation.	Point.	How determined.
Aberdeen	Monroe	184.18	Ry. station	Spirit level.
Abilene	Saline			
Acorn	Polk			
Actus	Sebastian	920	Village	Aneroid.
Ada	Conway	823	Village	Barometer.
Adams' Landing	Baxter	370		Spirit level.
Adamsville	Bradley			
Adler	Izard			
Afton	Fulton	426.10	Ry. station	Spirit level.
Agnos	Fulton			
Ain	Grant			
Akin Farm	Saline	525	Post-office	Aneroid.

ace.	County.	Elevation.	Point	How determined.
Akron	Independence	250		Aneroid.
Alabam	Madison			
Albertha	Randolph			
Albion	White			
Alco	Stone	1125	Post-office	Aneroid.
Alexander	Pulaski	325.10	Ry. station	Spirit level.
Alicia	Lawrence	253.60	Ry. station	Spirit level.
Allbrook	Howard			
Allen's Peak	Yell	1590	Summit	Barometer.
Alliance	Baxter			
Allis	Drew	193.10	Ry. station	Spirit level.
Alma	Crawford	431.80 433.63	Ry. station Bench-mark	Spirit level. Precise.
Almond	Cleburne	1140	Post-office	Aneroid.
Almyra	Arkansas			
Alpha	Yell	400	Post-office	Aneroid.
Alpine	Clark			
Alpine	Faulkner	426	Ry. siding	Spirit level.
Alread	Van Buren.	1680	Post-office	Aneroid.
Alston (White Oak)	Franklin	388.10 394.88	Ry. station Bench-mark	Spirit level. Precise.
Altharp	Saline;	405	Post-office	Aneroid.
Altheimer	Jefferson	207.58	Ry. station	Spirit level.
Altus	Franklin	535.20 540.99	Ry. station Bench-mark	Spirit level. Precise.
Alvis	Independence			
Aly	Yell	650	Post-office	Aneroid.
Amelia	Mississippi			
Amity	Clark			
Amos	Baxter	820	Post-office	Aneroid.
Anderson	Izard			
Anna	Crawford			
Annieville	Lawrence			
Annover	Cleveland			
Anoloko	Union			
Antimony	Howard	560	Post-office	Aneroid.
Antioch	White			
Antoine	Pike	257	Village	Spirit level.
Anvil	Stone			
Aplin	Perry	360	Post-office	Aneroid.
Appleton	Pope	520-550	Village	Aneroid.
Arcadia	Hempstead			
Archey	Van Buren			
Argenta	Pulaski	260.10 257 261.40 255.06	Baring Cross Ft. Smith Crossing. L. R. & M. Ry. Crossing Bench-mark	Spirit level. Spirit level. Precise.
Arkadelphia	Clark	186.10 	Ry. station Town	Spirit level.
Arkansas City	Desha	137.30 137.23 97	Warren Branch Ry. Bench-mark Low water, Miss. River	Spirit level. Precise. Spirit level.
Arkansas Post	Arkansas			
Armada	Crawford			
Armstrong	Sharp			
Armstrong Spring	White	250	Spring	Aneroid.
Arnett	Washington			

Place.	County.	Elevation.	Point.	How determined.
Arnold's Ferry	Independence	217		Spirit level
Arp	Pike			
Arthur	Conway			
Ashdown	Little River			
Ash Flat	Sharp			
Ashford	Crittenden			
Ashley Bayou	Lonoke	241.62	M. & L. R. Ry.	Spirit level.
Ashvale	Lonoke			
Askew	Lee			
Athelstan	Mississippi			
Atkins	Pope	353.50 354.17	Ry. station Bench-mark	Spirit level. Precise.
Atlanta	Columbia			
Attica	Randolph			
Atwood	Howard			
Auburn	Sebastian	490	Post-office	Aneroid.
Augsburg	Pope			
Augusta	Woodruff	211.10	Ry. station	Spirit level.
Aurich	Monroe	207.68 208.58	Miss & L. R. Ry. Cotton Belt Ry.	Spirit level. Spirit level.
Aurora	Madison			
Austin	Lonoke	248.10	Ry. station	Spirit level.
Auvergne	Jackson		Ry. station	
Ava	Perry	530	Post-office	Aneroid.
Avilla	Saline	583	Post-office	Barometer.
Avoca	Benton	1361.40	Ry. station	Spirit level.
Azor	Nevada			
Baker	Polk			
Baker's Bayou	Lonoke	220.62	M. & L. R. Ry. bridge	Spirit level.
Bald Dave	Baxter	1147	Summit	Aneroid.
Bald Knob	White	220 10	Ry. station	Spirit level.
Baldwin	Washington	1236.40	Ry. station	Spirit level.
Balloon	Yell	420	Post-office	Aneroid.
Bankhead	Jefferson		Ry. station	
Banner	Cleburne	957	Post-office	Aneroid.
Banty	Pulaski	490	Post-office	Aneroid.
Barber	Scott	495	Post-office	Aneroid.
Barcelona	Crawford			
Bard	Greene		Ry. station	
Bardstown	Mississippi			
Barfield	Mississippi			
Baring Cross	Pulaski	260.10	M. P. Ry. yard	Spirit level.
Barham (Sayre)	Ouachita	204.10	Ry. station	Spirit level.
Barkada	Drew			
Barker	Hempstead			
Barling	Sebastian			
Barnes	Franklin			
Barney	Faulkner			
Barren Fork (Drytown)	Izard	650–700	Village	Aneroid.
Barrettsville	Prairie			
Bartholomew	Ashley			
Barton	Phillips		Ry. station	
Batavia	Boone	1590	Post-office	Aneroid.
Batesville	Independence	268.10 268.07 265	Ry. station. B.M. 100 ft. N. of Ry. sta. L. bk. River nr. landing	Spirit level. Spirit level. Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Batson	Johnson			
Baucum	Pulaski	249.80	Ry. station	Spirit level.
Baxter	Drew	189.50	Ry. station	Spirit level.
Bay (Big Bay Siding)	Craighead	242.10	Ry. station	Spirit level.
Bayou de View	Woodruff	207.10	Ry. station	Spirit level.
Bayou Bartholomew	Drew	138	Ry at stream	Spirit level.
Bayou La Grue	Prairie	191.62	M. & L. R. Ry. bridge	Spirit level.
Bayou Meto	Arkansas	201.88	Ry. bridge	Spirit level.
Bayou Two Prairie	Lonoke	194.12	M. & L. R. Ry. bridge	Spirit level.
Bay Village	Cross			
Bear	Montgomery	621	Post-office	Aneroid.
Bear Creek	Boone	589.28	L. bk. White River 2000 ft. below mouth of creek	Spirit level.
Bear Creek	Searcy	1000	Post-office	Aneroid.
Bearden	Ouachita	238	Ry. station	Spirit level.
Bearskin	Lonoke	242.68	Ry. station	Spirit level.
Bear Wallow Spring	Logan	1380		Aneroid.
Beaty	Benton	1040	Honey Creek	Aneroid.
Beaver	Carroll	934.40	Ry. station	Spirit level.
Becker	Hot Spring		Ry. station	
Bedford	Sebastian			
Beebe	White	244.60	Ry. station	Spirit level.
Bee Branch	Van Buren			
Bee Creek	Marion (?)	599.83	L. bank White River below mouth of creek.	Spirit level.
Beirne	Clark	222.10	Ry. station	Spirit level.
Beith's Landing	Desha			
Belcher	Prairie	203.68	Ry. station	Spirit level.
Belfast	Grant			
Bellefonte	Boone	1086 1105	Valley W. of sec. 19, 18 N., 19 W Post-office	Spirit level. Aneroid.
Belleville	Yell	400	Town	Aneroid.
Belmont	Crawford	815	Post-office	Aneroid.
Belton	Sevier			
Belva	Scott	570	Post-office	Aneroid.
Bemis	Woodruff	218	Ry. station	Spirit level.
Benedict's Landing	Faulkner	279.79	Top of bank	Spirit level.
Bengay	Sharp			
Ben Lomond	Sevier			
Bennett's	Baxter	579	Post-office	Aneroid.
Benton	Saline	297.10 406	Ry. station Town	Spirit level. Aneroid.
Bentonville	Benton	1302.40	Ry. station	Spirit level.
Berea	Ashley			
Berlin (Piney)	Johnson	845.50 836.40	Ry. station Bench-mark	Spirit level Precise.
Bermuda	Arkansas			
Bern	Poinsett			
Berryville	Carroll	1295	Public square	Aneroid.
Bethel	Greene	284.10 280.50	St. L., I. M. & S. depot Cotton Belt depot	Spirit level. Spirit level.
Bethesda	Independence	575	Church	Aneroid.
Beulah	Prairie			
Beverly	Sebastian	535	Post-office	Aneroid.
Bexar	Fulton			

Place.	County.	Elevation.	Point.	How determined.
Bidville	Crawford			
Bien's Ford	Baxter	496		Aneroid.
Big Bend	Polk	950		Aneroid.
Big Bay Siding	Craighead		(See Bay)	
Big Creek	Boone	519.81	Rt. bk. White River, opp. mouth Big Ck.	Spirit level.
Big Creek	Cleveland	205	Ry. station	Spirit level.
Big Flat	Baxter	1280		Aneroid.
Big Fork	Polk			
Big Hickory	Columbia			
Big Rock	Pulaski	560		Vertical arc.
Billingsly	Washington		(See Moffit)	
Bills	Pike			
Bingen	Hempstead			
Bingham Springs	Perry			
Birdell	Randolph			
Birta	Yell	400	Post-office	Aneroid.
Bismarch	Hot Springs			
Biswell Springs	Sebastian	610	Village	Aneroid.
Blackburn	Washington			
Black Fork	Scott	857 840	L. O. Day's Post-office	Barometer. Aneroid.
Block Mountain	Van Buren	1370	Summit	Vertical arc.
Black Rock	Lawrence	259.10	Ry. station	Spirit level.
Black River	Independence	248	Ry. station	Spirit level.
Black River	Clay	288.10	St. L., I. M. & S. Ry	Spirit level.
Black River	Lawrence	281.10	K.C., F. S. & M. Ry. bdg	Spirit level.
Black Springs	Montgomery			
Blackville	Conway	327.40 823 68	Ry. station Bench-mark	Spirit level. Precise.
Blaine	Logan	400	Post-office	Aneroid.
Blakemore	Lonoke			
Blanchard Springs	Union			
Blanchton	Bradley			
Blanco	Searcy	675	Post-office	Aneroid.
Bland	Saline	450	Post-office	Aneroid.
Blansett	Scott	881	Post-office	Barometer.
Bledsoe	Lee			
Bliss	White			
Blocher	Saline	530	Post-office	Aneroid.
Bloomer	Sebastian	500	Village	Aneroid.
Bloomfield	Benton	1290	Post-office	Aneroid.
Bloyd's Mountain	Washington	2034	Summit	Aneroid.
Blue Ball	Scott	500	Post-office	Aneroid.
Blue Mountain	Garland	2000	Summit	Aneroid.
Blue Mountain	Scott	2800	Summit	Vertical arc.
Blue Mountain	Stone	 1700	(See Timbo) Summit south of Timbo	Aneroid.
Bluff City	Nevada			
Blufton	Yell	440	Post-office	Aneroid.
Blythe's Landing		402		Spirit level.
Blythesville	Mississippi			
Board Camp	Polk	980	Post-office	Aneroid.
Boat Mountain	Boone	2200	Summit	Aneroid.
Boat Mountain	Carroll	1550	Summit	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Bodcaw	Nevada			
Bodman	Drew			
Boggy	Miller			
Boles	Scott	694	Post-office	Aneroid.
Bolinger	Lafayette			
Bon Air Springs	Stone	1820	Resort	Aneroid.
Bonair	St. Francis		(See McDaniel)	
Bonnerville	Craighead		(See Bono)	
Bono (Bonnerville)	Craighead	261.10	Ry. station	Spirit level.
Bookman	Grant			
Boone	Boone			
Booneville	Logan	465	Post-office	Aneroid.
Boonsborough	Washington	1874	Post-office	Aneroid.
Boothe (Tomlinson)	Scott	591	Post-office	Barometer.
Booty	Arkansas			
Boston	Madison			
Boughton	Nevada	283.10	Ry. station	Spirit level.
Bowen	Pike			
Boxley	Newton	1210	Post-office	Aneroid.
Box Spring	Yell	680	Spring	Aneroid.
Boydsville	Clay			
Brad	White			
Bradford	White	241.10	Ry. station	Spirit level.
Bradley	Lafayette	276	Ry. station	Spirit level.
Bradshaw	Clark			
Bradshaw Creek	Clark	231	Sec. 18, 7 S., 21 W	Spirit level.
Bragg	Yell			
Bralix	Prairie			
Brawley	Scott	828	Post-office	Barometer.
Brazils	Saline	554	Post-office	Barometer.
Brentwood	Washington	1484.40	Ry. station	Spirit level.
Briar Creek	Logan	540	Church	Aneroid.
Briggsville	Yell	500	Post-office	Aneroid.
Bright Star	Miller			
Brightwater	Benton	1270.40 1216.40	Ry. station Sugar Creek	Spirit level. Spirit level.
Brinkley	Monroe	208.40	Ry. station	Spirit level.
Brisbane	Nevada			
Brister	Columbia			
Bristol	Faulkner			
Britton	Crawford	410	Post-office	Aneroid.
Brockett	Randolph			
Brocktown	Pike	394	Bottom Cr. 1 mile east	Spirit level.
Brookland	Craighead	261.50	Ry. station	Spirit level.
Brooks	Grant			
Brownstown	Sevier			
Bruno	Marion	940	Post-office	Aneroid.
Brushyville	Grant			
Bryant	Saline	357.10	Ry. station	Spirit level.
Buck Knob	Scott		Post-office	
Buck Knob Mountain	Scott	2850	Summit	Aneroid.
Buck Snort	Dallas	280	Cross-roads	Aneroid.
Buckner	Columbia	282	Ry. station	Spirit level.
Buckrange	Howard			

Place.	County.	Elevation.	Point.	How determined.
Buckville	Montgomery	545	Post-office	Aneroid.
Buena Vista	Ouachita	290	Ry. station	Spirit level.
Buffalo Gap	Garland	900	....	Aneroid.
Buffalo Lick	Poinsett	.....	....	
Buffalo City	Marion	....	(See Toney)	
Buford	Baxter	820	Post-office	Aneroid.
Bulger	Polk	......	....	
Bull Shoal	Boone	510.98	R. bank White R., head of shoal	Spirit level.
Burk	Saline	500	Post-office	Aneroid.
Burlington	Boone	1483	Sec. 20, 20 N., 21 W	Spirit level.
Burnet Springs	Logan	......	(See Corley)	
Burnville	Sebastian	585	Post-office	Aneroid.
Burrow Mountain	Conway	628	Summit	Barometer.
Butlerville	Lonoke	......	......	
Butterfield	Hot Spring	392	Ry. siding	Spirit level.
Buttry	Benton	......	......	
Byler	Izard	......	......	
Byron	Fulton	......	....	
Cabot	Lonoke	288.10	Ry. station	Spirit level.
Cabin Creek	Johnson	......	(See Lamar)	
Cache	Greene	290.10	Ry. station	Spirit level
Caddo Gap	Montgomery	......	......	
Cadron Creek bridge	Faulkner	282.59	Bench-mark	Precise.
Caglesville	Pope	740	Post office	Aneroid.
Calamine	Sharp	.. ..	.....	
Caldwell	St. Francis	255	Ry. station	Aneroid.
Caledonia	Union	....	......	
Calf Creek	Searcy	680	Village	Aneroid.
Calhoun	Columbia	......	....	
Calico Rock	Izard	331.21	L. bk. White River 800 ft. below Table Rock	Spirit level.
Calmer	Cleveland	......	....	
Camden	Ouachita	148.10	Cotton Belt station	Spirit level.
Camp	Fulton	......	....	
Campbell	Searcy	875	Village	Aneroid.
Canaan	Lee	225.40	Ry. station	Spirit level.
Cane Island	Craighead	.....	......	
Caney	Nevada	......	....	
Canfield	Lafayette	281	Ry. station	Spirit level.
Cannon	Benton	......	...	
Canton	Sharp	......	....	
Cany Fork	Pike	......	....	
Capark	Newton	......	....	
Carden's Bottom	Yell	325	Post-office	Aneroid.
Cardiff	Scott	1000	Post-office	Aneroid.
Carlisle	Lonoke	......	....	
Carmel	Chicot	......	....	
Carolan	Logan	575	Post-office	Aneroid.
Carper	Polk	......	....	
Carriola	Chicot	.... .	....	
Carrollton	Carroll	1280-1500	Public Square	Aneroid.
Carson's Lake	Mississippi	......	....	
Carter Store	Washington	1420	Post-office	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Casa	Perry	470	Post-office	Aneroid.
Cascade	Faulkner			
Cash	Craighead		Post-office	
Cass	Franklin			
Casscoe	Arkansas			
Cassville	Newton			
Catcher	Crawford			
Cato	Faulkner	305	Village	Aneroid.
Caulksville	Logan	460	Village	Aneroid.
Cauthron	Scott	600	Village	Aneroid.
Cavanaugh	Sebastian	490	Post-office	Aneroid.
Cave Creek	Newton	580	Post-office	Aneroid.
Cave Point	Stone	1150	Summit	Aneroid.
Cecil	Franklin	580	Post-office	Aneroid.
Cedar Creek	Scott	680	Post office	Aneroid.
Cedar Glades	Montgomery	537	Village.	Aneroid.
Cedarville	Crawford	810	Village	Aneroid.
Center	Sharp			
Center Ridge	Conway	675		Barometer.
Centerville	Yell	880	Village	Aneroid.
Center Hill	White	265	School-house	Aneroid.
Center Point	Howard	470	Court House	Aneroid.
Center Point	Logan	540	School-house	Aneroid.
Central	Sebastian	490	Post-office	Aneroid.
Cerro Gordo	Little River	407	Town	Aneroid
Chadwick	Faulkner			
Chalk	Van Buren			
Chalybeate Spring	Scott	840	Spring	Aneroid.
Chambersville	Calhoun	277	Village	Aneroid.
Champagnolle	Union			
Champion	Arkansas			
Chancel	Newton			
Chandler	Garland			
Chapel Hill	Sevier			
Charleston	Franklin	525	Town	Aneroid.
Charlotte	Independence			
Cheek	Phillips			
Cherokee City	Benton	1010	Post-office	Aneroid.
Cherry Grove	Grant			
Cherry Hill	Polk	880	Village	Aneroid.
Cherry Valley	Cross		(See Hickory Ridge)	
Chester	Crawford	840.40	Ry. station	Spirit level.
Chickalah	Yell	455	Post-office	Aneroid.
Chickasawba	Mississippi			
Chidester	Ouachita	230.90	Ry. station	Spirit level.
Chip	Union			
Chismville	Logan	535	Post-office	Aneroid.
Chocoville	Sebastian	720	Village	Aneroid.
Choctaw	Van Buren	460	Village	Aneroid.
Chula	Yell			
Cinda	Mississippi			
Cincinnati	Washington			
Claremore	Pulaski			
Clarendon	Monroe	125	Ry. station, Cotton Belt	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Clarketon	Crittenden	229.10	Ry. station	Spirit level.
Clarkson	Sharp			
Clarksville	Johnson	365.10 367.77	Ry. station Bench-mark	Spirit level. Precise.
Claude	Van Buren			
Claunch	Craighead			
Clay	White			
Clayton	Nevada			
Clear Lake	Mississippi			
Clear Point Ridge	Prairie	224.68	L. R. & M. R. Ry.	Spirit level.
Clear Spring	Clark	384		Spirit level.
Clear Water	White			
Clem	Perry			
Clementine	Benton			
Cleveland	Conway	771	Post-office	Barometer.
Clifton (Felton)	Lee	219.30	Ry. station	Spirit level.
Clifty	Madison			
Cline	Johnson			
Clinton	Van Buren	516	Court House	Barometer.
Clio	Cleveland			
Clover Bend	Lawrence			
Clow	Hempstead			
Clyde	Washington			
Coal Hill	Johnson	468 472.57	Ry. station Bench-mark	Spirit level. Precise.
Coats	Sharp			
Cobbs	Lonoke	235	Post-office	Aneroid.
Coffee Creek	Phillips			
Coffeyville	Jackson			
Coin	Carroll			
Cold Spring	Scott	1060	Spring	Aneroid.
Coleborough	Little River			
Colegrove	White			
Coleman	Drew			
College Hill	Columbia			
Collegeville	Saline	440	Post-office	Aneroid.
Collins	Drew	167.40	Ry. station	Spirit level.
Colona	Woodruff		Ry. station	
Colony Lake	Clay	282.60	Ry. station	Spirit level.
Colt	St. Francis	236	Ry. station	Aneroid.
Columbus	Hempstead			
Colville	Benton			
Combs	Madison	1406.40	Ry. station	Spirit level.
Como	Cleveland	200	Post-office	Aneroid.
Compton	Newton	2210	Post-office	Aneroid.
Concord	Union			
Confederate Home	Pulaski	312	Building	Vertical arc.
Convenience	Independence			
Conway	Faulkner	308.60 319.29	Ry. station Bench-mark	Spirit level. Precise.
Cooper	St. Francis			
Copeland	Van Buren	808	Post-office	Barometer.
Copper Spring Mt'n	Van Buren	1544	Summit	Vertical arc.
Coras	Cleburne			
Cord	Independence			

Place.	County.	Elevation.	Point.	How determined.
Corinth	Howard	......		
Corley	Logan	1425	Post-office	Aneroid.
Cornell's Landing		355.59	L. bank White River 500 below Ldg.	Spirit level.
Cornerstone	Jefferson	.....		
Cornerville	Lincoln	......		
Cornie	Union			
Corning	Clay	289.10	Ry. station	Spirit level.
Corwin	Saline	......		
Cotton Belt	Columbia	......		
Cotton Plant	Woodruff	......		
Cove	Polk			
Cove Creek	Hot Spring	274.10	Bridge abutment	Spirit level.
Covington	Calhoun	.....		
Cow Mountain	Stone	1276	Summit	Vertical arc.
Cox's Spring	Scott	945	Spring	Aneroid.
Craig's Mill	Saline	265	Post-office	Aneroid.
Cravens	Franklin	525	Post-office	Aneroid.
Crawfordville	Crittenden	221 10	Ry. station	Spirit level.
Creech	Benton	......		
Crescent	Sebastian	......		
Crockett	Clay	.....		
Crockett's Bluff	Arkansas	......		
Cromwell	Jackson	......		
Crooked Creek	Lonoke	205.62	M. & L. R. Ry. bridge	Spirit level.
Crosses	Madison	1388.40	Ry. station	Spirit level.
Crow	Scott	508	Post-office	Aneroid.
Crowell Pinnacle	Van Buren	1446	Summit	Barometer.
Crowley	Greene	......		
Crowley's Ridge	Cross	342	Summit, Bald Knob Branch Ry.	Spirit level.
Crump	Benton	1125		Aneroid.
Crystal Springs	Montgomery	675	Summit	Aneroid.
Culberhouse	Craighead	......		
Culp	Baxter	......		
Cummins	Lincoln	......		
Curia	Independence	550	Post-office	Aneroid.
Curtis	Clark	186.10	Ry. station	Spirit level.
Cushman	Independence	707.10	Ry. station	Spirit level.
Cypert	Phillips	......		
Cypress Fork	Columbia	......		
Cypress	Ashley	110.72	Ry. station	Spirit level.
Dahoma	Franklin	550	Post-office	Aneroid.
Dalark	Dallas	242.50	Ry. station	Spirit level.
Dale	Johnson	......		
Daleville	Clark	182.40	Ry. station	Spirit level.
Dallas	Polk	1089	Court House	Barometer.
Dalton	Randolph	......		
Damascus	Faulkner	......		
Damon	Yell	380	Post-office	Aneroid.
Danville	Yell	387	Court House	Barometer.
Dardanelle	Yell	330 314	Level of town River bottom opposite	Aneroid. Spirit level.
Darysaw	Grant	......		
Davenport	White	......		

Place.	County.	Elevation.	Point.	How determined.
Davis	Johnson			
Dayton	Sebastian	650	Post-office	Aneroid.
De Ann	Hempstead			
Deaslee	Lafayette			
Debie	Searcy			
Decatur	Benton	1220		Spirit level.
Deckard Mountain	Perry	2100	Summit	Aneroid.
Dee (ridge)	Craighead	288.10	Ry. station	Spirit level.
DeKalb	Cleburne			
Delaney	Madison	1861.40	Ry. station	Spirit level.
Delaplaine	Greene	277 60	Ry. station	Spirit level.
Delaware	Logan	400	Post-office	Aneroid.
Del Monte	Pulaski			
Delta	Nevada			
Deluce	Arkansas			
Denieville (James)	Independence	416.10	Ry. station	Spirit level.
Denmark	White			
Dannard	Van Buren			
Denton's Ferry	Baxter	435.09	White River, left bank	Spirit level.
Denver	Carroll			
Dermott	Chicot	140.90	Ry. station	Spirit level.
De Roche	Hot Spring			
Des Arc	Prairie			
Desha	Independence	278	Post-office	Aneroid.
Desoto	Union			
Devall's Bluff	Prairie	193.58	Ry. station	Spirit level.
DeView	Woodruff			
DeWitt	Arkansas			
Dexter	Jefferson		Ry. station	
Diamond	Van Buren	1665	Post-office	Aneroid.
Diaz*	Jackson	230.10	Ry. station	Spirit level.
Dickey	Pulaski	240		Aneroid.
Dickson	Benton	1840	Post-office	Aneroid.
Dilolo	Union			
Dinsmore	Newton	1520	Post-office	Aneroid.
Dixie	Perry	325	Post-office	Barometer.
Dob	Calhoun			
Divide	Conway	480	Post-office	Aneroid.
Dobyville	Clark			
Dodd City	Marion	1100	Post-office	Aneroid.
Doe Branch	Pulaski	465	Post-office	Aneroid.
Dogwood	Grant			
Don	Clay			
Donald	Franklin	520	Post-office	Aneroid.
Donaldson	Hot Spring	228.10	Ry. station	Spirit level.
Dora.	Crawford			
Dorietta	Franklin	760	Village	Aneroid.
Dota	Independence			
Double Wells	Jefferson			
Douglas	Lincoln			
Dove Park	Hot Spring		Post-office	
Dove Park Springs	Hot Spring	340	Spring	Aneroid

*Junction of Batesville Branch with the main line of the St. Louis, Iron Mountain and Southern Railway.

Place.	County.	Elevation.	Point.	How determined.
Dover	Pope	448	Sec. 21, 9 S., 20 W	Spirit level.
Dowling	Ouachita			
Doyle	Hempstead			
Drake's Creek	Madison	1810	Post-office	Aneroid.
Driggs	Logan	628	Post-office	Barometer.
Dryden	Craighead			
Dry Fork	Carroll	1400	Post-office	Aneroid.
Dry Run	Dallas	226(?)	Ry. station	Spirit level.
Drytown	Izard		(See Barren Fork)	
Dublin	Logan	490	Post-office	Aneroid.
Duckett	Howard			
Duff	Searcy	650	Post-office	Aneroid.
Dugger Mills	Boone	990	Post-office	Aneroid.
Dumas	Desha		Ry. station	
Dump	Washington			
Duncan	Monroe		Ry. station	
Dunn	Monroe			
Dunnam	Lonoke		(See Keo)	
Durant	Garland			
Durham	Washington	1247.40	Ry. station	Spirit level.
Dutch Mills	Washington			
Dutton	Madison			
Dyer	Crawford	426.50 427.74	Ry. station Bench-mark	Spirit level. Precise.
Eads	Crawford			
Eagle Gap	Polk	1510	Toll-gate	Aneroid.
Eagle Hill	Polk	950	Village	Aneroid.
Eagle Mills	Ouachita			
Earl	Crittenden	222.60	Ry. station	Spirit level.
East Mountain	Washington	1734	Summit nr. Fayetteville.	Aneroid.
Ebb	Grant			
Ebony	Crittenden			
Echo	Scott			
Economy	Pope			
Edgar	St. Francis			
Edge	Van Buren	800	Post-office	Aneroid.
Edil	Lincoln			
Edmonson	Crittenden			
Edwards	Independence			
Effa	Franklin			
Egbert	White			
Egger (Cherry Hill)	Polk	880	Village	Aneroid.
Eglantine	Van Buren	424	Post-office	Barometer.
Egypt	Lawrence			
Eight Mile	Jackson			
El Dorado	Union			
Eldridge	Howard			
Elerson	Jefferson			
Eleyville	Hempstead			
Elgin	Jackson			
Eli	Jackson			
Elixir	Boone	1025	Post-office	Aneroid
Elizabeth	Fulton	810	Post-office	Aneroid.
Elkhorn	Benton	1577	Tavern	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Elkins	Washington	1221.40	Ry. station	Spirit level.
Ella	Van Buren			
Elliot	Ouachita			
Ellsworth	Logan	590	Post-office	Aneroid
Elm	Clark			
Elmo	Independence	250	Post-office	Aneroid.
Elmo	Crittenden	226.10	Ry. station	Spirit level.
Elmore	Hot Spring			
Elmot	Mississippi			
Elm Spring	Washington	1304	Post-office	Aneroid.
Elm Store	Randolph			
Elmwood	Boone			
Elon	Ashley			
El Paso	White			
Emmet	Nevada	294 67	Ry. station	Spirit level.
Enders	Faulkner			
England	Lonoke	228.80	Ry. station	Spirit level.
Engle	Izard	430	Post-office	Aneroid.
English	Jefferson	285(?)	Ry. station	Spirit level.
Enola	Faulkner			
Ensign	Pulaski	295.10	Ry. station	Spirit level.
Enterprise	Sebastian	490	Post-office	Aneroid.
Epsy	Yell			
Era	Miller			
Erin	Grant			
Eros	Marion	1125	Post-office	Aneroid.
Esau	Perry	280	Post-office	Aneroid.
Esther	Franklin			
Ethel	Arkansas			
Etna	Franklin	530	Village	Aneroid.
Etta	Hot Spring	243.10	Ry. station	Spirit level.
Euclid	Howard			
Eureka Springs	Carroll	1143.40 1463	Ry. station Crescent Hotel	Spirit level. Aneroid.
Evans	Ouachita	216	Ry. station	Spirit level.
Evansville	Washington			
Evening Shade	Sharp			
Excelsior	Sebastian	580	Post-office	Aneroid.
Eye	Calhoun			
Fairchild	Garland			
Fairfield	Jefferson		Ry. station	
Fairmount	Prairie	222.68 221.62	L. R. & M. R. Ry M. & L. R. Ry.	Spirit level. Spirit level.
Fairplay	Saline	400	Post-office	Aneroid.
Fairview	Dallas	182	Ry. station	Aneroid.
Fairview	Independence		(See Pleasant Plains.)	
Faith	Jefferson			
Fakes	Woodruff	200.40	Ry. station	Spirit level.
Falcon	Nevada			
Fallsville	Newton	2000	Post-office	Aneroid.
Fancher	Madison			
Fancy Hill	Montgomery			
Farmer	Scott	680	Post-office	Aneroid.
Farmington	Washington	1204	Post-office	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Farmville	Bradley	....	....	
Faulkner Gap	Faulkner	815	Post-office	Aneroid.
Faulkner's Lake	Pulaski	250.68	L. R. & M. R. Ry.	Spirit level.
Fawn	Searcy	1030	Post-office	Aneroid.
Fay	Hempstead	......	....	
Fayetteville	Washington	1340.40 ..	Ry. station. Ark. Industrial Uni..	Spirit level.
Fayette Junction	Washington	1243.4	Junction St. Paul Branch Ry.	Spirit level.
Featherston	Mississippi	....	....	
Felker	Franklin	498.90	Ry. siding	Spirit level.
Felton	Lee	219.80	Ry. station	Spirit level.
Fenter	Grant	......	....	
Fern	Franklin	...	....	
Filbert Ferry	......	443.64	L. bank White River 200 below ferry	Spirit level.
Finch	Greene	......	....	
Finch Mountain	Stone	1508	Summit	Verticle arc.
Fine's Spring	Crawford	815	Spring	Aneroid.
Finn	Ouachita	151	Ry. station	Spirit level.
First Creek	Cross	217.90	Ry. station	Spirit level.
Fisher	Poinsett	......	Ry. station.	
Fitzpatrick	Lee	......	....	
Fletcher	Pulaski	380	Post-office	Aneroid.
Flint	Benton	......	....	
Flippin	Marion	650	Post-office	Aneroid.
Flora	Fulton	......	....	
Floral	Independence	720	Post-office	Aneroid.
Florence	Drew	......	....	
Flowery	Franklin	......	....	
Floyd	White	......	....	
Foran Gap	Scott	1255	....	Aneroid.
Ford	Jackson	......	....	
Fordyce	Dallas	259.46	Ry. station	Spirit level.
Forked Mountain	Perry	1400	Summit	Aneroid.
Forrest City	St. Francis	278.16	Ry. crossing	Spirit level.
Fort Douglas	Johnson	......	....	
Fort Logan	Howard	......	....	
Fort Lynn	Miller	......	....	
Fort Smith	Sebastian	419.40 446.26	Ry. station. U. S. Jail	Spirit level. Precise.
Forum	Madison	.. ...	....	
Fouke	Miller	......	....	
Fountain Hill	Ashley	......	....	
Fourche Dam	Pulaski	245	Post-office	Verticle arc.
Francis	Boone	1140	Post-office	Aneroid.
Franklin	Izard	.....	....	
Freeman	Pope	......	....	
French Port	Ouachita	.. ..	....	
Friendship	Hot Spring	......	....	
Frisco (Porter)	Crawford	1092.40	Ry. station	Spirit level.
Fritz	Crittenden	......	....	
Frost	Miller	......	....	
Fuller	Scott	630	Post-office	Aneroid.
Fulton	Hempstead	259.10 267.10	Ry. station Ry. bridge, Red River	Spirit level. Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Gadsden	Cleburne			
Gaines Landing	Chicot			
Gainesville	Greene	336	Ry. station	Spirit level.
Gaither	Boone			
Galena	Howard			
Galla Creek	Pope	369.54 358.60	Bench-mark Ry. station	Precise. Spirit level.
Galla Rock	Pope		(See Holla Bend)	
Gallatin	Benton			
Galloway	Pulaski	249.61	Ry. station	Spirit level.
Gammiel	Franklin	525	Post-office	Aneroid.
Garfield	Benton	1519.40	Ry. station	Spirit level.
Garland	Miller	246	Ry. station	Spirit level.
Garlandville	Hempstead			
Garner	White	220.60	Ry. station	Spirit level.
Garnett	Lincoln			
Garretson's Landing	Jefferson			
Garvey (W. Memphis)	Crittenden	221.10 220.70	K. C., S. & M. Ry. sta. St. L., I. M. & S. Ry. sta.	Spirit level. Spirit level.
Gaskins	Carroll	1034.40	Ry. siding	Spirit level.
Gassville	Baxter	725	Town	Aneroid
Gassville Landing	Baxter	417.93	White River 100 ft. above Ldg. left bk.	Spirit level.
Gate	Scott	925	Post-office	Barometer.
Gavin	Crittenden	221.10	Ry. station	Spirit level.
Gaynor's Ferry	Independence	247.68	White River, Rt. bank.	Spirit level.
Genoa	Miller	379	Ry. station	Spirit level.
Gentry	Pike			
George's Creek	Marion	760	Post-office	Aneroid.
Germantown	Conway	302.90 304 70	Ry. station Bench-mark	Spirit level. Precise.
Gid	Izard	396	Post-office	Aneroid.
Gifford	Hot Spring	331.10	Ry. station	Spirit level.
Gilkeson	Craighead	293	Ry. station	Spirit level.
Gilkey	Yell			
Gillet	Arkansas			
Gilmore	Crittenden	229.10	Ry. station	Spirit level.
Gin	Cleburne			
Gipson	Scott	600	Post-office	Aneroid.
Gladstone	Garland			
Glaize Creek	White	208.40	Ry. station	Spirit level.
Glasgow	Lafayette			
Glen	Carroll			
Glendale	Lincoln			
Glenville	Nevada			
Gold Creek	Faulkner	294.10	Ry. station	Spirit level.
Golden City	Logan	550	Post-office	Aneroid.
Golden Lake	Mississippi			
Goldman	Arkansas	198.58	Ry. station	Spirit level.
Goodwin	St. Francis	206.40	Bridge	Spirit level.
Goshen	Washington	1284	Post-office	Aneroid.
Grab	Polk			
Grace	Johnson	625	Post-office	Aneroid.
Grace	Jefferson	240	Ry. station	Spirit level.
Grady	Lincoln		Ry. station	

Place.	County.	Elevation.	Point.	How determined.
Graham	Independence	485	Post-office	Aneroid.
Grand Glaise	Jackson	223.10	Ry. station	Spirit level.
Grand Prairie	Prairie	224.62	Highest point in, on M. & L. R. Ry.	Spirit level.
Grange	Sharp			
Grapevine	Grant			
Graphic	Crawford	850	Post-office	Aneroid.
Gravelly Hill	Yell	469	Post-office	Barometer.
Gravel Ridge	Bradley			
Grays	Woodruff		Ry. station	
Grayson	Crittenden			
Graywood	Cleveland			
Greely	Jefferson			
Greenback	Jefferson			
Greenboro	Craighead			
Greenbrier	Faulkner			
Greenfield	Poinsett	198	Ry. station	Spirit level.
Green Forest	Carroll	1420	Post-office	Aneroid.
Greenland	Washington	1250.40	Ry. station	Spirit level.
Green Ridge	Scott	830	Post-office	Aneroid.
Greenway	Clay	289.50	Ry. station	Spirit level.
Greenwood	Sebastian	555	Court House	Aneroid.
Greer	Jefferson			
Greersburg	Washington		(See Tolu)	
Greer's Ferry	Cleburne	311		Barometer.
Gregory	Woodruff		Ry. station	
Grove	Drew			
Griffin Springs	White	880	Spring	Aneroid.
Grigsby's Ferry	Independence	261.09	Rt. bk. White River	Spirit level.
Grubbs	Jackson			
Gubertown	Craighead			
Guernsey	Hempstead		Ry. station	
Gum Log	Pope			
Gum Springs	Clark		Ry. station	
Gurdon	Clark	208.10	Ry. station	Spirit level.
Hackett	Sebastian	587.40	Ry. station	Spirit level.
Hackler	Crittenden			
Hagarville	Johnson	550	Village	Aneroid.
Hagler	Arkansas			
Halcomb	Sevier			
Hale	Crawford			
Half Moon Mountain	Stone	1370	Summit	Aneroid.
Halley	Desha	137.30	Ry. station	Spirit level.
Halliday	Greene		Ry. station	
Halstead	Pulaski	363	Post-office	Aneroid.
Hamburg	Ashley		Court House	
Hamilton	Lonoke	222	Post-office	Spirit level.
Hamlet	Faulkner			
Hamlin	Cross	220.80	Ry. station	Spirit level.
Hammonsville	White			
Hampton	Calhoun	223	Court House	Aneroid.
Hanks	Van Buren	1525	Post-office	Aneroid.
Hanover	Stone			
Harbour	Calhoun			

Place.	County.	Elevation.	Point.	How determined.
Hardy	Sharp	343.10	Ry. station	Spirit level.
Harlow	Calhoun	......	Ry. station.	
Harmony	Johnson	540	Post-office	Aneroid.
Haroldton	Crawford	......		
Harris	Washington	1201.40	Ry. station	Spirit level.
Harrisburgh	Poinsett	284.10	Ry. station	Spirit level.
Harrison	Boone	1100	Valley east of sec. 3, 18 N., 20 W.	Spirit level.
Harrisonville	Jackson	......		
Hartford	Sebastian	645	Post-office	Aneroid.
Hartley	Polk	......		
Hartley Mountain	Van Buren	1878	Summit	Vertical arc.
Hartman	Johnson	363 90 404.64	Ry. station Bench-mark	Spirit level. Precise.
Harwood Island	Chicot	......		
Hatchie Coon	Craighead	230.10	Ry. station	Spirit level.
Hattie Mountain	Van Buren	1850	Summit	Aneroid.
Hattieville	Conway	380	Post-office	Aneroid.
Hawes	Garland	525	Post-office	Aneroid.
Hay	Drew	......	Ry. station.	
Haynes	Lee	222.90	Ry. station.	
Hazel Grove	Independence	.....		
Hazel Valley	Washington	......		
Hazen	Prairie	......	Ry. station	
Head	Lonoke	227.18	Ry. station	Spirit level.
Hearne	Clark	......		
Heber	Cleburne	485	Court House	Aneroid.
Hebron	Clark	.....		
Heckatoo	Lincoln	.....		
Hector	Pope	765	Post-office	Aneroid.
Helena	Phillips	193.40 202.90 141	St.L.,I.M.& S.Ry. sta. Ry. crossing Low water, Miss. River	Spirit level. Spirit level. Spirit level.
Henderson	Baxter	500	Village	Aneroid.
Henderson's Knob	Searcy	1905	Summit	Barometer.
Henrico	Desha	......		
Hensley	Saline	250	Ry. station	Spirit level.
Hepsey	Marion	......		
Herd	Benton	......		
Hermitage	Bradley	......		
Herndon	Greene	...		
Hewett's Mill	Washington	1194		Aneroid.
Hickory Plains	Prairie	...		
Hickory Ridge	Cross	284.60	Ry. station	Spirit level.
Hickory Station	Montgomery	......		
Hickory Valley	Independence	591	Post-office	Aneroid.
Hicks	St. Francis	224.90	Ry. station	Spirit level.
Hicksville	Phillips	......		
Hico	Benton	......		
Higgins n	White	220.10	Ry. station	Spirit level.
Highland	Sharp	......		
Hight (Pleasant Val.)	Franklin	410.20	Post-office	Spirit level.
Hillsboro	Union	......		
Hill Top	Boone	2210	Post-office	Aneroid.
Hillville	Chicot	.....		

Place.	County.	Elevation.	Point.	How determined.
Hindsville	Madison	1800	Post-office	Aneroid.
Hiram	Cleburne.	......		
Hobart	Logan	685	Post-office	Aneroid.
Holla Bend (Galla R'k)	Pope	370	Post-office	Aneroid.
Holland	Faulkner	......		
Holland	Lonoke	255.10	Ry. station	Spirit level.
Hollis	Perry	530	Village	Aneroid.
Holly Grove	Monroe	......	Ry. station	
Holly Springs	Dallas	280	Post-office	Aneroid.
Hollywood	Clark	275		Estimated.
		297	Divide, N. E. qr. sec. 32, 7 S., 21 W.	Spirit level.
Homan	Miller	266.10	Ry. station	Spirit level.
Hoover	Benton	......		
Hope	Hempstead	352.10	Ry. station	Spirit level.
Hopefield	Crittenden	......	Ry. station	
Hopeville	Calhoun	330	Post-office	Aneroid.
Hopkin's Spring	Benton	1182	Spring	Aneroid.
Hopper	Montgomery	......		
Hopper Landing	Marion	406.98	Left bank White River.	Spirit level.
Horace	Pulaski	......		
Horsehead	Columbia	......		
Hot Springs	Garland	604	Malvern Ave. & Silver St.	Spirit level from Little Rock.
		601	Sill Arkansas Nat. Bank Building	Spirit level.
		1445	Rector's Heights	Aneroid.
Hottentot	Carroll	1400	Post-office	Aneroid.
Houston	Perry	377		Barometer.
Howe	Phillips	207.10	Ry. station	Spirit level.
Howell	Woodruff	......	Ry. station	
Hoxie	Lawrence	268.10	Ry. station	Spirit level.
Hubbard	Washington	......		
Hudson	Ouachita	......		
Hudspeth	Chicot	134.70	Ry. station	Spirit level.
Huffman	Mississippi	......		
Hughes	Crittendon	......		
Huma	Phillips	196.90	Ry. station	Spirit level.
Humphrey	Arkansas	......		
Humphreys	Jefferson	186.58	Ry. station	Spirit level.
Hunt	Johnson	560	Post-office	Aneroid.
Hunter	Woodruff	213	Ry. station	Spirit level.
Hunter's Mountain	Van Buren	1160	Summit	Aneroid.
Huntington	Sebastian	567.40	Ry. station	Spirit level.
Huntsville	Madison	1525	Court House	Aneroid.
Hurds	Chicot	......	Ry. station	
Hurricane	Saline	340	Post-office	Aneroid.
Hyde Park	Phillips	......		
Hydrick	Cross	......		
Ico	Grant	......		
Ida	Cleburne	......		
Idell	Logan	......		
Ilion	White	......		
Illinois Creek	Pope	325.79	L. R. & F. S. Ry. bridge	Precise.
		483	Junction of North Fork	Spirit level.
		628	Junction of Middle Fork	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Imboden	Lawrence	282.10	Ry. station	Spirit level.
Independence	Baxter			
Indian Bay	Monroe			
Indian Bayou	Lonoke	221.62	M. & L. R. Ry. bridge	Spirit level.
Indian Creek	Carroll			
Ingalls	Bradley			
Ingram	Randolph			
Ink	Polk	1050	Post-office	Aneroid.
Ionia	Benton			
Irons Mountain	Stone	1553	Summit	Vertical arc.
Ironton	Pulaski	325		Aneroid.
Island	Sebastian			
Iuka	Izard	860	Post-office	Aneroid.
Ivanhoe	Searcy			
Ivesville	Pulaski	325	Village	Aneroid.
Ivy	Dallas	300	Post-office	Aneroid.
Jacinto	Dallas	235	Post-office	Aneroid.
Jacks Creek	Jackson	242	Ry. Station	Spirit level.
Jacksonport	Jackson	201.07	U. S. Eng. River gage	Spirit level.
Jacksonville	Pulaski	282.10	Ry. station	Spirit level.
Jakajones	Hempstead		(See Denieville)	
James	Independence			
Jamestown	Independence	300	Post-office	Aneroid.
Jasper	Newton			
Jay	Logan			
Jefferson (Jeff. Sp'gs)	Jefferson	 338.31	Ry. station Temp. Bench-mark	 Precise.
Jennings Falls	Yell	400	Village	Aneroid.
Jenny Lind	Sebastian	460	Ry. Station	Aneroid.
Jenson	Sebastian	543.40	Ry. station	Spirit level.
Jericho	Crittenden			
Jersey	Bradley			
Jerusalem	Conway			
Jessieville	Garland			
Joan	Clark			
Joberta	Woodruff			
Johnson	Washington	1194.40	Ry. station	Spirit level.
Johnsville	Bradley			
Jones Bayou	Pulaski	243.68	L. R. & M. R. Ry	Spirit level.
Jonesborough	Craighead	300.10 311.[illegible]0	K. C., S. & M. depot Cotton Belt depot	Spirit level. Spirit level.
Jones' Mill	Lafayette		Ry. station	
Jordanbrook	Sevier			
Judea	Madison			
Judsonia	White	217.10	Ry. station	Spirit level.
Julious	Crittenden			
Jumbo	Izard			
Junet	Grant			
Junior	Saline			
Kearney	Jefferson	 349.74	Ry station Temp. Bench-mark	 Precise.
Kedron	Cleveland	205	Ry. station	Spirit level.
Keevil	Monroe	186	Ry. station	Spirit level.
Keller	Little River		Ry. station	
Kemp	Ouachita			

Place.	County.	Elevation.	Point.	How determined.
Kendall	Faulkner	336	Post-office	Aneroid.
Kensett	White	224.10	Ry. station	Spirit level.
Kenyon	Jackson			
Keo (Dunnam)	Lonoke	232	Ry. station	Spirit level.
Kerr's	Lonoke	255	Ry. station	Aneroid.
Key	Benton			
Keyton	Clark			
Killgore	Newton			
Kinard	Union			
Kinderhook	Cleburne	440	Post-office	Aneroid.
Kingsland	Cleveland	208	Ry. station	Spirit level.
King's Mill	Sharp			
Kingston	Madison	1330	Post-office	Aneroid.
Kingsville	Randolph			
Kirby	Pike			
Kirk	Saline			
Knobel	Clay	280.10	Ry. station	Spirit level.
Knoxville	Johnson	393.20 393.70	Ry. station Bench-mark	Spirit level. Precise.
Krumm's Mill	Woodruff	196.40	Ry. station	Spirit level.
LaBelle	Saline	420		Aneroid.
Lacey	Drew			
Lackland	Nevada			
Laconia	Desha			
LaCrosse	Izard			
Ladd's Mill	Washington	1074	Ford of Ill. River	Aneroid.
LaGrange	Lee	207.90	Ry. station	Spirit level.
Lake City	Craighead			
Lake Farm	Jefferson			
Lakeport	Chicot			
Lake Village	Chicot			
Lamar	Johnson	404.10 409.04	Ry. station Bench-mark	Spirit level. Precise.
Lamberton	Monroe			
Lambethville	Crittenden			
Lamp	Van Buren			
Lanark	Bradley			
Lancaster	Crawford	623.40	Ry. station	Spirit level.
Laneburgh	Nevada			
Langley	Pike			
L'Anguille River	Lee	203.90	Ry. bridge	Spirit level.
Lansing	Crittenden			
Lapile	Union			
Larue	Benton			
Latham	Van Buren			
Latour	Phillips	202.70	Ry. station	Spirit level.
Laughlin	Columbia			
Laurel	Pope	700	Post-office	Aneroid.
Lavaca (Oak Bower)	Sebastian	480	Village	Aneroid.
Lawrence	Garland	336	Ry. station	Spirit level.
Layton	Jackson			
Lead Hill	Boone	650	Sugar Loaf Creek	Aneroid.
Leard	Clark			
Leatherwood	Carroll	942.40	Ry. siding	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Lebanon	Sevier			
Lecont	Pulaski			
Lecroy	Hot Spring	274.10	Bridge abutment	Spirit level.
Lee	Lee			
Leedsville	Cross			
Lee's Creek	Crawford			
Lehigh	Cleveland			
Lemric	Sevier			
Leon	Franklin	530	Post-office	Aneroid.
Leslie (Wiley's Cove)	Searcy	1036	Village	Barometer.
Lester	Ouachita		Ry. station	
Levesque	Cross	229.10	Ry. station	Spirit level.
Lewisburg	Conway	262 26 293.60	Low water mark Bench-mark	Spirit level. Spirit level.
Lewisville	Lafayette	283	Ry. station	Spirit level.
Lexa	Phillips	209.40	Ry. station	Spirit level.
Lexington	Van Buren			
Liberty	Ouachita			
Lightle	Monroe			
Lilley	Ouachita	145	Ry. station	Spirit level.
Lillie	Crawford	452.40	Ry. station	Spirit level.
Lima	Randolph			
Limestone Valley	Newton			
Lincoln	Washington			
Linder	Faulkner			
Lindsay	Lawrence			
Lindville	Johnson			
Linwood	Jefferson		Ry. station	
Lisbon	Union			
Lissie	Pike			
Lithia	Lawrence			
Little Bay	Calhoun	324	Ry. station	Spirit level.
Little Red	White			
Little Red River	White	217.10	Ry. bridge	Spirit level.
Little River	Little River			
Little River	Sevier	212.50	Bottom of River, Sec. 22, 11 S., 29 W.	Spirit level.
Little Rock	Pulaski	259.10 287.06 297.65	Union depot State House, U. S. B. M. Custom House, U.S. Bench-mark	Spirit level. Precise. Precise.
Lively	Hempstead			
Liverpool	Sebastian	600	Village	Aneroid.
Livingston	Stone	370	Post-office	Aneroid.
Lloyd	Pope			
Loafer's Glory	Newton	1987	Village	Aneroid.
Lochinvar	Lafayette			
Lockesburgh	Sevier			
Locust Bayou	Calhoun			
Locust Cottage	Jefferson			
Lodi	Pike			
Logan	Benton			
Lollie	Faulkner			
London	Pope	371.90 378.15	Ry. station Bench-mark	Spirit level. Precise.
Lone Elm Church	Scott	765	Church	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Lone Grove	Woodruff	......	(See Gregory)	
Lonelm	Franklin	520	Post-office	Aneroid.
Lone Rock	Baxter	750 1000	Post-office Top of peak	Aneroid. Aneroid.
Long's Ferry	Boone	554.50	Low water at Ferry	Spirit level.
Long View	Ashley	......		
Lono	Hot Spring	540	Village	Aneroid.
Lonoke	Lonoke	......	Ry. station, C. H	
Lookout Gap	Scott	1110		Aneroid.
Lorado	Green	......		
Lost Mountain	Conway	942	S. E. bluff	Barometer.
Lost Mountain	Searcy	2200	Summit	Aneroid.
Louann	Ouachita	......		
Loulyma	Green	......		
Lowe	Jackson	......		
Lowell	Benton	1346.40	Ry. station	Spirit level.
Lowry	Boone	......		
Loyal	Sharp	640	Post office	Aneroid.
Lucky	Montgomery	......		
Ludwig	Johnson	......		
Luella	Drew	......		
Lufra	Ouachita	......		
Lulu	St. Francis	......		
Lumber	Columbia	......		
Luna Landing	Chicot	......		
Lunenburg	Cleburne	405	At Wolf Bayou	Aneroid.
Lunet	Ouachita	......		
Lunsford	Craighead	......		
Lutherville	Johnson	775	Village	Aneroid.
Lynn	Lawrence	......		
McAlmont	Pulaski	271.10	Ry. station	Spirit level.
McBee Landing	Marion	435		Aneroid.
McCrory	Woodruff	209.40	Ry. station	Spirit level.
McDaniel	St. Francis	280.90	Ry. station	Spirit level.
McGavock	Mississippi	......		
McGehee	Desha	146 148.86	Ry. station Bench-mark	Spirit level. Precise.
McGehee Junction	Desha	145	Railway	Spirit level.
McKinney	Cleveland	......		
McNeil	Columbia	333	Ry. station	Spirit level.
McPhearson	Baxter	650	Post-office	Aneroid.
McRae	White	......	Ry. station	
Mabelvale	Pulaski	308.10	Ry. station	Spirit level.
Macedonia	Columbia	......		
Macey	Craighead	......		
Madding	Jefferson	......		
Maddry	Hot Spring	......		
Madison	St. Francis	220	Ry. station	Aneroid.
Magazine	Logan	460	Post office	Aneroid.
Magazine Mountain	Logan	2823	Crest	Barometer.
Magness' Ferry	Independence	280		Aneroid.
Magnet	Hot Spring	525	Post-office	Vertical arc.
Magnolia	Columbia	......	Ry. station	
Malvern	Hot Spring	278.10	Ry. station Court House	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Mammoth Spring	Fulton	512.10	Ry. station	Spirit level.
Mandeville	Miller	314.10	Ry. station	Spirit level.
Manfred	Montgomery	......		
Mangrum	Craighead	......		
Manoah	Drew	......		
Mansfield	Sebastian	596.40	Ry. station	Spirit level.
Mantee	Madison	......		
Maple	Carroll	1225	Post-office	Aneroid.
Marble	Madison	1300	Post-office	Aneroid.
Marcella	Stone	345	Post-office	Aneroid.
Marche	Pulaski	267 267.57	Ry. station Bench-mark	Spirit level. Precise.
Marianna	Lee	285.70	Ry. station	Spirit level.
Marion	Crittenden	225.10	Ry. station	Spirit level.
Mark	Sebastian	525	Village	Aneroid.
Marked Tree	Poinsett	229.10	Ry. station	Spirit level.
Markel's Mill	Boone (?)	1070	Mill	Aneroid.
Marmaduke	Greene	271.50	Ry. station	Spirit level.
Marr	Columbia	......		
Marsden	Bradley	......		
Marshall	Searcy	1036	Court House	Barometer.
Mars Hill	Lafayette	......		
Martha	Howard	......		
Martin	Woodruff	201.40	Ry. crossing	Spirit level.
Martin's Creek	Sharp	......		
Martinville	Faulkner	390	Post-office	Aneroid.
Marvell	Phillips	......	Ry. station	
Marvinville	Yell	400	Post-office	Aneroid.
Mason Valley	Benton	......		
Massard	Sebastian	550	Post-office	Aneroid.
Matney's Knob	Baxter	1222+	Summit	Aneroid.
Maumelle	Pulaski	360	Post-office	Aneroid.
Maumelle Pinnacle	Pulaski	1000	Summit	Aneroid.
Maxville	Sharp	650	Village	Aneroid.
May	Garland	......		
Mayflower	Faulkner	285.50 286.08	Ry. station Bench-mark	Spirit level. Precise.
Maynard	Randolph	......		
Maysville	Benton	1180	"Old town"	Aneroid.
Mazarn	Montgomery	......		
Mead	St. Francis	220	Ry. station	Aneroid.
Mebaneville	Cross	......		
Medford	Desha	......		
Melbourne	Izard	......	Court House	
Mendenhall	Nevada	......		
Menifee	Conway	285.50 285.13	Ry. station Bench-mark	Spirit level. Precise.
Meredith	Woodruff	......		
Meyers	Garland	......		
Michener	Clay	......		
Middlebrook	Randolph	......		
Midway	Drew	......		
Midway	Monroe	186	Ry. station	Spirit level.
Milan	Yell	460	Post-office	Aneroid.
Milford	Sevier	......		

Place.	County.	Elevation.	Point.	How determined.
Mill Creek	Pope	830.40 823.98	Ry. station Bench-mark	Spirit level. Precise.
Mill Creek	Stone	603	Mouth of creek	Aneroid.
Milliken	Little River		Ry. station	
Milltown	Sebastian	600	Post-office	Aneroid.
Millville	Ouachita			
Millwood	Little River			
Milner	Columbia			
Milo	Ashley			
Milton	Miller			
Mineral	Pulaski	395	Post-office	Aneroid.
Mineral Springs	Howard	300		Spirit level.
Minneola	Little River			
Minturn	Lawrence	260.60	Ry. station	Spirit level.
Mist	Ashley			
Mitchell	Fulton	825	Post-office	Aneroid.
Mixer	Pope	358.30	Ry. station	Spirit level.
Moark	Clay	297.10	Ry. station	Spirit level.
Mobley	Independence			
Modoc	Phillips			
Moffit (Billingsly)	Washington			
Monarch	Marion	850	Post-office	Aneroid.
Money	Logan			
Monroe	Monroe		Ry. station	
Montana	Johnson	388.90	Ry. station	Spirit level.
Monticello	Drew	271.40	Ry. station	Spirit level.
Montongo	Drew			
Montreal	Sebastian	521.40	Ry. station	Spirit level.
Montsville	Bradley			
Mooney's Ferry	Marion	436	White River	Spirit level.
Moore	Faulkner			
Moorefield	Independence	310.10	Ry. station	Spirit level.
Moreland	Pope			
Morganton	Van Buren			
Moro	Lee			
Moro Bay	Bradley			
Morrell	Ashley	132.97	Ry. station	Spirit level.
Morrillton	Conway	377.20 386.03	Ry. station Bench-mark	Spirit level. Precise.
Morrison Bluff	Logan	425	Village	Aneroid.
Morrow	Washington			
Morton	Woodruff	223.40	Ry. station	Spirit level.
Mossville	Newton			
Motz	Miller			
Moulton	Columbia			
Mound City	Crittenden			
Mount Adams	Arkansas			
Mount Evans	Van Buren	1460	Summit	Aneroid.
Mountainburgh	Crawford	714.40	Ry. station	Spirit level.
Mountain Fork	Polk	1000	Post-office	Aneroid.
Mountain Glen	Garland	450	Post-office	Aneroid.
Mountain Home	Baxter	799	Court House Square	Aneroid.
Mountain Top	Franklin			
Mountain Valley	Garland	814	Post-office	Barometer.

Place.	County.	Elevation.	Point.	How determined.
Mountain View	Stone	730	Court House	Barometer.
Mount Hersey	Newton	750	Town	Aneroid.
Mount Holly	Union			
Mount Ida	Montgomery	674	Post-office	Barometer.
Mount Judea	Newton			
Mount Levi	Johnson			
Mount Moriah	Nevada			
Mount Nebo	Yell	1760	Summit	Aneroid.
Mount Olive	Izard	345	Post-office	Aneroid.
Mount Parthenon	Newton			
Mount Pisgah	White	660	Summit	Aneroid.
Mount Pisgah Church	Logan	860	Church	Aneroid.
Mount Vernon	Faulkner.			
Mouth Salado Creek	Independence	232		Aneroid.
Mouth St. Francis R.	Phillips			
Muddy Fork	Howard			
Mulberry	Franklin	391 388.18	Ry. station Bench-mark	Spirit level. Precise.
Mundell	Carroll	1075	Post-office	Aneroid.
Murfreesboro	Pike	354		Spirit level.
Murillo	Van Buren			
Murray	Newton			
Murta	Lawrence	270.60	Ry. station	Spirit level.
Music Creek	Marion	507.93	R. br. White Riv., 500 ft. below mouth of Music Creek	Spirit level.
Myatt	Fulton			
Myrtle	Boone			
Naked Joe	Baxter	1016	Summit	Aneroid.
Narrows	Carroll	934.40	Ry. station	Spirit level.
Nashville	Howard	352.10	Ry. station	Spirit level.
Nathan	Pike			
National	Logan	495	Post-office	Aneroid.
Natural Dam	Crawford			
Neal	Sebastian	555		Aneroid.
Nebo	Benton	1220	Village	Aneroid.
Nebraska	Scott	538	Post-office	Aneroid.
Needmore	Lonoke			
Neelly	Yell	320	Post-office	Aneroid.
Negro Hill	White		Post-office	
Nelson	Drew		Ry. station	
Nelson's Ferry	Baxter	381.08	Rt. bank White River	Spirit level.
Nettleton	Craighead	258.10	Ry. station	Spirit level.
Newark	Independence	239.70	Ry. station	Spirit level.
Newburg	Izard		Post-office	
New Castle	St. Francis	355	Village	Aneroid.
New Edinburg	Cleveland			
New Gascony	Jefferson		Ry. station	
New Hope	Pike			
New Lewisville	Lafayette		Ry. station	
New London	Union			
New Moon	Howard			
Newport*	Jackson	227.10 230.22	Ry. station U. S. Monument	Spirit level. Spirit level.

*The railway track has been raised at New Port since this elevation was determined; it is not known how much. Levels from the U. S. Bench-mark on the river bank, 400 feet N. of the elevator, make the top rail opposite the south end of the passenger station 233.07 A. T.

Place.	County.	Elevation.	Point.	How determined.
Nichols	Polk			
Nimrod	Perry	400	Post-office	Aneroid.
Nix	Dallas	215	Post-office	Aneroid.
Noah	Newton			
Noble's Lake	Jefferson	...... 201.49	Ry. station Bench-mark	Precise.
Nodena	Mississippi			
Noland	Randolph			
Norphlet	Union		(Formerly Jess)	
North Creek	Phillips			
North Point	Pulaski	300	Post-office	Aneroid.
Northwood	Pope			
Norwoodville	Sevier			
Nubia	Jefferson			
Nuna	Saline			
Nutt	Calhoun			
Oak Bower	Sebastian		(See Lavaca)	
Oak Flat	Van Buren			
Oak Forest	Lee			
Oak Grove	Carroll			
Oak Hill	Carroll	1123	Post-office	Aneroid.
Oakland	Marion	650	Post-office	Aneroid.
Oakland	Drew		Ry. station	
Oak Valley	Sebastian	500	Village	Aneroid.
Oar	Independence			
Oark	Johnson			
O'Bear	Craighead	254	Ry. station	Spirit level.
Obin	Grant			
Oden	Montgomery	790	Post-office	Barometer.
Ogamaw	Ouachita			
Ogden	Little River			
Oil Trough (See Jacksonport)	Independence	201.07	U. S. Eng. River gage.	Spirit level.
O'Kean	Randolph	270.60	Ry. station	Spirit level.
Okolona	Clark		Ry. station	
Ola	Yell	397	Post-office	Barometer.
Old Clem Place	Independence	490		Aneroid.
Old Hickory	Conway	475	Post-office	Aneroid.
Olena	Arkansas			
Olio	Scott	660	Post-office	Aneroid.
Oliver Spring	Crawford	800	Spring	Aneroid.
Olivet	Carroll			
Olmstead	Pulaski			
Olyphant	Jackson	220.10	Ry. station	Spirit level.
Oma	Hot Spring			
Omaha	Boone	1373	Sec. 22, 21 N., 21 W	Spirit level.
Omega	Carroll	1360	Post-office	Aneroid.
O'Neil's Mill	Dallas	560	Mill	Aneroid.
Onset	Marion	680	Post-office	Aneroid.
Onyx	Yell	940	Post-office	Aneroid.
Ophir	Montgomery			
Oppelo	Conway	320	Post-office	Aneroid.
Opposition	Lawrence			
Ops	Hot Spring			

Place.	County.	Elevation.	Point.	How determined.
Optimus	Stone	980	Post-office	Aneroid.
Oregon	Boone	1275	Post-office	Aneroid.
Orien	Grant	......	......	
Orlando	Cleveland	......	......	
Osage	Carroll	1390	Post-office	Aneroid.
Osage Mills	Benton	......	......	
Osceola	Mississippi	......	......	
Otto	Faulkner	......	......	
Ouachita River	Clark	196.10	Bridge at Arkadelphia	Spirit level.
Ouita	Pope	354.70 354.13	Ry. station Bench-mark	Spirit level. Precise.
Owensville	Saline	400	Post-office	Aneroid.
Owlet	Prairie	......	......	
Oxford	Izard	......	......	
Ozan	Hempstead	356.10	Ry. station	Spirit level.
Ozark	Franklin	376.60 398.36	Ry. station Bench-mark	Spirit level. Precise.
Ozone	Johnson	1550	Post-office	Aneroid.
Pace's Ferry	Marion	477	White River	Spirit level.
Pactolus	Benton	......	......	
Padora	Washington	......	......	
Palarm	Faulkner	268.30 268.79	Ry. station Bench-mark	Spirit level. Precise.
Palatka	Clay	......	......	
Palestine	St. Francis	211.40	Ry. station	Spirit level.
Palmer	Monroe	......	Ry. station	
Palmyria	Lincoln	......	......	
Pangburn	White	......	......	
Panola	Lonoke	......	......	
Pansy	Cleveland	......	......	
Panther Mountain	Stone	1510	Summit	Vertical arc.
Paragould	Greene	282.20 280.31	St.L.,I.M & S.Ry.depot Cotton Belt depot	Spirit level. Spirit level.
Parham	Monroe	217.58	Ry. station	Spirit level.
Paris	Logan	445	Court House	Aneroid.
Parkdale	Ashley	118.55	Opposite depot	Spirit level.
Parker's Store	Pulaski	410	Post-office	Aneroid.
Parkin	Cross	222.10	Ry. station	Spirit level.
Park Place	Lee	......	......	
Parks	Scott	668	Post-office	Aneroid.
Parn	Benton	......	......	
Parnell	Lonoke	......	......	
Paroquet	Independence	235.80	Ry. station.	Spirit level.
Parsonville	Lawrence	......	......	
Pastoria	Jefferson	217.71	B. M., upper end	Spirit level.
Pates	Howard	......	......	
Patrick (Powell)	Madison	1362.40	Ry. station	Spirit level.
Patsie	Logan	380	Post-office	Aneroid.
Patterson Bluff	Logan	350-380	Village	Aneroid.
Patterson's Mill	Dallas	160	Mill	Aneroid.
Pauline	Franklin	580	Post-office	Aneroid.
Paxson	White	......	......	
Peach Orchard	Clay	285.10	Ry. station	Spirit level.
Pearcy	Garland	......	......	
Pea Ridge	Benton	......	Post-office	

Place.	County.	Elevation.	Point.	How determined
Pea Ridge (Big Mt.)	Benton	1682	Summit	Aneroid.
Pea Ridge (Little Mt.)	Benton	1583	Summit	Aneroid.
Pearl	Pope			
Pearson	Cleburne			
Pecan Point	Mississippi			
Pedlo	Boone	990		Aneroid.
Peel	Marion	860	Town	Aneroid.
Pembina	Baxter			
Pendleton	Desha			
Peoria	Sebastian			
Perrin's Ferry	Izard	342		Aneroid.
Perryville	Perry	290 825		Spirit level. Aneroid.
Peru	Randolph			
Peters	Lee			
Petersburg	Ashley			
Petit Jean	Conway	1100	Top of Mt. south of mouth of Petit Jean Creek.	Aneroid.
Pettus	Lonoke	223	Post-office	Spirit level.
Petty	Sevier			
Peytonville	Little River			
Philips Bayou	Lee			
Picayune	Howard			
Pickler	Columbia			
Piedmont	Pulaski			
Pierce Mountain	Washington	1734	Summit	Aneroid.
Piggott	Clay	286.50	Ry. station	Spirit level.
Pillow	Phillips			
Pilot Knob	Scott	2100	Summit	Aneroid.
Pinchback's Mills	Cleveland	280	Post-office	Aneroid.
Pinckney	Crittenden			
Pine Bluff	Jefferson	211.58 223.32	Ry. station Normal School Bldg.	Spirit level. Precise.
Pinecastle	Bradley			
Pine City	Monroe			
Pine Grove	Dallas	250	Post-office	Aneroid.
Pine Mountain	Van Buren	1849	Summit	Barometer.
Pine Mountain	Izard	953	Summit	Vertical arc.
Pineville	Izard	675	Post-office	Aneroid.
Piney	Carroll	1580	Post-office	Aneroid.
Piney	Johnson		(See Berlin.)	
Piney Creek	Izard	318.60	Mouth of Creek	Spirit level.
Pinnacle Springs	Faulkner	504	Village	Aneroid.
Pitkin (Woolsey	Washington	1377.40	Ry. station	Spirit level.
Pitman	Clay			
Plainfield	Columbia			
Plantersville	Drew			
Plata	Montgomery			
Pleasant Plains (Fairview)	Independence	581	½ mile S. of Post-office	Aneroid.
Pleasant Hill	Franklin	450	Village	Aneroid.
Pleasant Hill	Benton	1320	School-house	Aneroid.
Pleasant Ridge	Boone	1080	Post-office	Aneroid.
Pleasant Valley	Franklin	410.20	Ry. station	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Plum Bayou	Jefferson	224.12	Bk. of Ark. River 30 feet above mouth of Bayou	Spirit level.
Plummerville	Conway	285.60 290.34	Ry. station Bench-mark	Spirit level. Precise.
Plymouth	Franklin			
Pocohontas	Randolph			
Poe	Grant			
Poindexter	Crittenden	179	Ry. station	Spirit level.
Poepping	Franklin	378.60 381.56	Ry. siding Bench-mark	Spirit level. Precise.
Point Ceder	Hot Spring			
Point Peter	Searcy	2000	Summit	Barometer.
Point Peter	Searcy	725	Old post-office	Aneroid.
Point Remove	Conway	299.10	Ry. station	Spirit level.
Polk Bayou	Sharp	500	Post-office	Aneroid
Polk Bayou	Independence	267	Railway	Aneroid.
Pollard	Clay			
Polo	Carroll			
Pond	Benton			
Pond Mountain	Carroll	1699	Summit	Aneroid.
Pond Mountain	Cleburne	1360	Summit	Aneroid.
Pontiac	Polk			
Pontoon	Yell			
Poor Mountain	Benton	1820	Summit	Aneroid.
Popular Grove	Phillips			
Porter	Crawford	1092.40	Ry. station	Spirit level.
Portia	Lawrence	262.10	Ry. station	Spirit level.
Portland	Ashley	128.15	Ry. station	Spirit level.
Potash Sulphur	Garland	400	Hotel	Aneroid.
Potter	Polk	1025	Village	Aneroid.
Potts' Station (Galla Creek)	Pope	353.60 269.54	Ry. station Bench-mark	Spirit level. Precise.
Poughkeepsie	Sharp			
Powell	Craighead	264.60	Ry. station	Spirit level.
Powell	Marion	750	Post-office	Aneroid.
Powell	Madison			
Powers	Johnson			
Powhatan	Lawrence			
Prairie Beach Ldg	Independence	261.37	Stone mon., R. bank White River	Spirit level.
Prairie Grove	Washington	1094	Town	Aneroid.
Prairie View	Logan	420	Village	Aneroid.
Prattsville	Grant			
Prescott	Nevada	323.10	Ry. station	Spirit level.
Preston	Lee	220.70	Ry. station	Spirit level.
Preston	Faulkner	270 70 271.63	Ry. station Bench-mark	Spirit level. Precise.
Prime	Cleburne			
Princeton	Dallas	244	Court House	Spirit level.
Puckett	Benton	1076	Post-office	Aneroid.
Quincy	Newton			
Quitman	Cleburne	480	Post-office	Estimated.
Quito	Polk	1020	Post-office	Aneroid.
Raiford	Calhoun			
Rally Hill	Boone	1130	Post-office	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Ramsey	Dallas	285	Post-office	Aneroid.
Randall	Cleveland	......		
Randolph	Sebastian	585	Post-office	Aneroid.
Ranger	Yell	390	Post-office	Aneroid.
Rankin	Little River	......		
Ransom	Polk	......		
Raum	Carroll	......		
Ravenden	Lawrence	301.10	Ry. station	Spirit level.
Ravenden Springs	Randolph	......		
Ray	Lonoke	202.68	Ry. station	Spirit level.
Raymond	Monroe	......		
Rector	Clay	287.50	Ry. station	Spirit level.
Red Bluff	Jefferson	230.75 226.42	Opp. left side of river Top of bank, right side.	Spirit level. Spirit level.
Redemption	Perry	275	Post-office	Aneroid.
Redfield	Jefferson	... 306.59	Ry. station Bench-mark	 Precise.
Red Fork	Desha	......		
Red Hill	Van Buren	1863	Summit	Barometer.
Red River (Fulton)	Hempstead	267.10	Ry. bridge	Spirit level.
Red Rock	Newton	......		
Red Store	Phillips	......		
Reed	Sharp	......		
Reed's Creek	Sharp	.....		
Reed's Landing	Pulaski	243.97	General level	Spirit level.
Reedville	Desha	......	Ry. station	
Reform	Saline	730	Post-office	Aneroid.
Register	Hempstead	......		
Relf's Bluff	Lincoln	......		
Remmel	Jackson	......		
Remond	Ouachita	......		
Rest	Lincoln	......		
*Reves Knob	Searcy	2043	Summit	Barometer.
Revilee	Logan	600	Post-office	Aneroid.
Reyno	Randolph	......		
Reynold's Spur	Pulaski	281	Ry. station	Spirit level.
Rea's Mills	Washington	......		
Rhode's Mill	Boone	1150	Residence	Aneroid.
Richmond	Little River	309	Town	Spirit level.
Rich Mountain	Polk	2750	Summit	Aneroid.
Rickert	Washington	......		
Ridge	Craighead	......	(See Dee)	
Riley	Yell	......		
Rio Vista	White	208.40	Ry. station	Spirit level.
Ripley	Cleveland	......		
Rison	Cleveland	225	Ry. station	Spirit level.
Riverside	Woodruff	......	Ry. station	
Rives	Drew	......		
Roberts	Miller	......	Ry. station	
Robinson	Benton	1016	Railway survey	Spirit level.
Rob Roy	Jefferson	......		
Rob Roy Station	Jefferson	203.58	Ry. station	Spirit level.
Rock Creek	Pike	......		
Rockford	Izard	......		

Place.	County.	Elevation.	Point.	How determined.
Rockhouse	Madison	.....	....	
Rocky	Polk	1000	Post-office	Aneroid.
Rocky Comfort	Little River	437	Court House...........	Aneroid.
Roe..................	Monroe..........	217.58	Ry. station.............	Spirit level.
Roff..................	Polk.............	.. ..	....	
Rogers...............	Benton..	1385.40	Ry. station.............	Spirit level.
Roland	Pulaski	260	Post-office	Aneroid.
Romance	White	......	....	
Roper Mountain.....	Stone	1675	Summit	Verticle arc.
Rosadale.............	Howard..........	......	....	
Rose Bud	White	......	....	
Roseville.............	Logan	400	Village	Aneroid.
Rosie	Independence....	260	Post-office	Aneroid.
Ross	Lonoke	223.68	Ry. station	Spirit level.
Rossmere	Chicot............	......	....	
Rosston	Nevada....	......	....	
Round Mountain.....	Faulkner.........	570	Summit	Aneroid.
Round Mountain.....	Polk........	2300	Summit	Aneroid.
Round Mountain.....	Stone	1500	Summit	Aneroid.
Round Top	Benton............	1125	Village.	Aneroid.
Rover	Yell	400	Village.................	Aneroid.
Rowell...............	Cleveland........	.....	.. ..	
Roy..................	Pike..	......	....	
Rozelle	Mississippi..	......	....	
Rudd	Carroll...........	.....	....	
Rudy	Crawford.........	498.40	Ry. station......	Spirit level.
Rufus................	Jackson	.....	....	
Rugby...............	Washington......	1250.40	Ry. station............	Spirit level.
Rule	Carroll...........	1320	Post-office........	Aneroid.
Rush	Marion...........	550	Post-office	Aneroid.
Rushing..............	Stone	1080	Post-office	Aneroid.
Russell...............	White............	233.10	Ry. station	Spirit level.
Russellville	Pope.............	338.20 348.56	Ry station .... Bench-mark............	Spirit level. Precise.
Ruth	Fulton	....	....	
Rye..................	Sebastian	580	Village	Aneroid.
Ryker..	Newton	......	....	
Sage	Izard.......	......	....	
Saint Benedict	Logan	550	Monastery..............	Aneroid.
Saint Charles....	Arkansas.	......	....	
Saint Clair...........	Crittenden........	......	....	
Saint Francis.........	Clay..............	294.50	Ry. station	Spirit level.
St. Francis River bridge........	St. Francis.......	212.40 182.60	L. R. & M. Ry. bridge . Bottom of stream	Spirit level.
Saint James (Buck Horn).............	Stone	580	Post-office..............	Aneroid.
St. Joe.	Searcy	750	Post-office	Aneroid.
Saint Paul............	Madison..........	1500.40	Ry. station	Spirit level.
Saint Thomas........	Crittenden	......	....	
Saint Vincent........	Conway...........	580	Church.................	Aneroid.
Salado.	Independence....	420	½ mile W. of post-office..	Aneroid.
Salem	Sebastian	705	Village	Aneroid.
Salem................	Fulton............	......	Court House	
Saline..	Dallas............	260	Post-office..............	Aneroid.
Saline................	Bradley..........	123.60	Ry. station	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Saline River..........	Saline............	284.10	St. L., I. M. & S. Ry. bridge	Spirit level.
Saltillo...............	Faulkner.........	......	....	
Salvador.............	Phillips...........	......	....	
Sanders..............	Hot Spring.......	......	....	
Sand Point...........	Crawford.........	......	....	
Sandtown	Independence....	411	Younger's Mill.........	Aneroid.
Sandy Springs.......	Grant............	820	Post-office	Aneroid.
Sang.	Van Buren.......	......	....	
Sans Souci...........	Mississippi.......	......	....	
Sara	Hot Spring.......	......	....	
Sarassa	Lincoln	......	....	
Saratoga	Howard	......	....	
Sardis................	Hempstead.......	......	....	
Sassafras.............	Arkansas.........	......	....	
Savoy..	Washington... ..	......	....	
Sayre (See Barham)..	Ouachita.	......	....	
Scanlan..............	Crittenden.......	......	....	
Scipio	Drew	......	....	
Scotland	Van Buren.......	705	Village.................	Barometer.
Scott.................	Lonoke	249.80	Ry. station	Spirit level.
Scottsville...........	Pope.............	475	Village	Aneroid.
Searcy	White............	260	Court House	Aneroid.
Seatonville	Lonoke	207.68	Ry. station.............	Spirit level.
Seay..................	Woodruff	.....	....	
Seba..................	Benton	1352	Post-office	Aneroid.
Sedgwick............	Lawrence	262.10	Ry. station	Spirit level.
Seelig.................	Lee	......	....	
Selma	Drew	......	....	
Seminary	Ouachita.........	......	....	
Settlement...........	Van Buren	540	Post-office..............	Aneroid.
Sexton.	Washington......	......	....	
Seyppel	Crittenden	......	....	
Shamrock............	Calhoun..........	......	....	
Shark................	Yell	380	Post-office..............	Aneroid.
Sharman.............	Columbia	......	....	
Sharp's Cross Roads.	Independence....	385	Post-office..............	Aneroid.
Shaver...............	Boone	......	....	
Shaw	Saline............	......	....	
Shawmut	Clark	......	....	
Shelton............ ..	Hempstead	......	....	
Sheppard	Hempstead	280.10	Ry. station	Spirit level.
Sheridan*	Grant	300	Lower part.............	Spirit level.
Sherrill	Jefferson.........	216.80	Ry. station.............	Spirit level.
Shiloh	Cleburne.........	403	....	Barometer.
Shinall Mountain	Pulaski	1055	Summit	Aneroid.
Shoal Creek..........	Logan............	410	Post-office	Aneroid.
Shoppach	Saline............	720	Post-office	Aneroid.
Shover Spring........	Hempstead	......	....	
Shuler	Union	......	....	
Siddell.	Saline	.....	....	
Sidney...............	Sharp	......	....	
Sidon	White............	.....	....	

*Main part of town is about 50 feet higher.

Place.	County.	Elevation.	Point.	How determined.
Silex	Pope	810	Village	Aneroid.
Siloam Springs	Benton	1110	Town	Aneroid
Silver City	Montgomery	680		Aneroid.
Silver Hill	Sevier			
Silver Springs	Benton	1085	Spring	Aneroid.
Simpson	Bradley			
Sims	Montgomery	740	Post-office	Aneroid.
Sixmile	Franklin	525	Village	Aneroid.
Skelton's	Carroll	965.40	Ry. siding	Spirit level.
Slack	Conway			
Slate	Saline			
Slatonville	Sebastian	740	Post-office	Aneroid.
Sleeth	Jefferson			
Smackover	Ouachita			
Smackover Creek	Ouachita	92.80	Bottom of creek at Camden & Alex. Ry. bridge.	Spirit level.
Smart (Smart Switch)	Jefferson		Ry. station	
Smead	Calhoun			
Smeadley	Johnson	450	Post-office	Aneroid.
Smithdale	Cross			
Smithton	Clark	205.60	Ry. station.	Spirit level.
Smith's Pinnacle	Saline	1900	Summit	Aneroid.
Smithville	Lawrence			
Smyrna	Pope			
Snapp	Woodruff			
Snow	Newton			
Snowball	Searcy	730	Post-office	Aneroid.
Snow Lick Mountain	Van Buren	1873	Summit	Barometer.
Snyder	Ashley			
Social Hill	Hot Spring			
Soldier Rock	Stone	313.27	Rt. bk. White River opposite.	Spirit level.
Solgohachia	Conway	450	Post-office	Aneroid.
Son's Chapel	Washington	1564	Church	Aneroid.
South Bend	Lincoln			
Southern Home	Yell			
South Fork	Fulton			
Southland	Phillips			
Spadra	Johnson	378 376.12	Ry. station. Bench-mark	Spirit level. Precise.
Speir	Crawford	590	Post-office	Aneroid.
Spence	Newton			
Spielerville	Logan	495	Post-office	Aneroid.
Spinola	Union			
Spotville	Columbia			
Spring Bank	Miller			
Spring Creek	Independence	271 284	Railway	Aneroid.
Spring Creek	Lee			
Springdale	Washington	1325.40	Ry. station	Spirit level.
Springfield	Conway	418	Village	Barometer.
Spring River Bridge	Lawrence	289.10	Ry. bridge	Spirit level.
Springtown	Benton	1210		Spirit level.
Spring Valley	Washington			

Place.	County.	Elevation.	Point.	How determined.
Square Rock Church	Scott	730	Church	Aneroid.
Stainer	Lonoke	237.68	Ry. station	Spirit level.
Stamps	Lafayette			
Star City	Lincoln			
Starne Springs	Independence	800	Village	Aneroid.
Star of the West	Pike			
Stattler	Crawford	940	Post-office	Aneroid.
Staunton (Greenland)	Washington	1250.40	Ry. station	Spirit level.
Staves	Cleveland			
Stephens	Ouachita	234	Ry. station	Spirit level.
Sterling	Chicot			
Stevens Creek	White			
Stone	Marion	625	Post-office	Aneroid.
Stonewall	Greene			
Stop	Crawford			
Story	Montgomery	700	Post-office	Aneroid.
Stottsville	Craighead			
Stout's Landing	Conway	290		Aneroid.
Stranger's Home	Lawrence			
Strawberry	Lawrence			
Strickler	Washington			
Stringtown	Independence	250	Village	Aneroid.
Sturgis	Bradley			
Stuttgart	Arkansas	210.58	Ry. station	Spirit level.
Sub Rosa	Franklin	615	Post-office	Aneroid.
Sugar Grove	Logan	445	Post-office	Aneroid.
Sugar Loaf	Sebastian	600	Post-office	Aneroid.
Sugar Loaf Mtn	Garland	1180	Summit	Aneroid.
Sugar Loaf Mtn	Sebastian	2100	Summit	Aneroid.
Sugar Loaf Mtn	Stone	1175	Summit	Aneroid.
Sugar Loaf Mtn	Van Buren	1004	Summit	Barometer.
Sugar Mountain	Washington	2090	Summit	Aneroid.
Sullivan	Scott	858	Post-office	Aneroid.
Sulphur City	Washington			
Sulphur Rock	Independence	308.60 355	Ry. station Town	Spirit level. Aneroid.
Sulphur Springs	Benton	905		Spirit level.
Sulphur Springs	Montgomery	582		Barometer.
Summers	Washington		Village	
Summerville	Calhoun			
Summit	Newton			
Summit Home	Washington	1887.40	Surface above tunnel	Spirit level.
Sumpter	Bradley			
Sunny Side	Chicot			
Sunrise	White			
Sunset	Washington			
Sunshine	Ashley			
Supply	Randolph			
Surrounded Hill	Prairie			
Sutton	Nevada			
Swain	Newton			
Swan Lake	Jefferson		Ry. station	
Sweet Home	Pulaski	260	Ry. station	Vertical arc.
Swifton	Jackson	248	Ry. station	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Sycamore	Boone	680	Post office	Aneroid.
Sylamore	Stone	300.14	Rt. bk. White River	Spirit level.
Sylarsville	Lee	......		
Sylva	Marion	900	Post-office	Aneroid.
Tan Trough Cr	Izard	337	Mouth of creek	Aneroid.
Tackett	Montgomery	......		
Tarry	Lincoln	......		
Tate	Scott	500	Village	Aneroid.
Tatumville	Saline	520	Post-office	Aneroid.
Ten Mile	Fulton	......		
Terre Noir Cr	Clark	217	Sec. 31, 7 S., 21 W	Spirit level.
Texarkana	Miller	298.10	St. L., I. M. & S. Ry. station	Spirit level.
Thomasville	Izard	......		
Thompson	Madison	1281.40	Ry. station	Spirit level.
Thornton	Calhoun	321	Ry. station	Spirit level.
Three Brothers	Baxter	1360	Summit	Aneroid.
Three Creeks	Union	......		
Thurman	Clay	......		
Tichnor	Arkansas	......		
Tillar	Drew	151.94	Bench-mark	Precise.
Tilton	Cross	......	Ry. station	
Timbo (Blue Mt.)	Stone	820	Post-office	Barometer.
Tina	Cleburne	1010	Post-office	Aneroid.
Tolbert's Ferry		444	White River	Spirit level.
Toledo	Cleveland	......		
Tollete	Howard	......		
Toltec	Lonoke	236.80	Ry. station	Spirit level.
Tomahawk	Searcy	745	Post-office	Aneroid.
Tomberlins	Lonoke	......		
Tomlinson (see Boothe)	Scott	591		Barometer.
Toney (Buffalo City)	Marion	390.48 422.31	60 feet below warehouse Mon. 500 ft. above ldg	Spirit level. Spirit level.
Toronto	Jefferson	......	Ry. station	
Totten	Pulaski	450	Post-office	Aneroid.
Trafalgar	Ashley	......		
Traskwood	Saline	288.10	Ry. station	Spirit level.
Trenton	Phillips	......		
Trident	Benton	......		
Trippe	Desha	111.90	Ry. station	Spirit level.
Troy	Ouachita	......		
Tucker	Jefferson	221.80	Ry. station.	Spirit level.
Tuckerman	Jackson	241.60	Ry. station	Spirit level.
Tulip	Dallas	480	Post-office	Aneroid.
Tull	Grant	......		
Tulu (Greersburg)	Washington	......		
Tupelo	Jackson	......	Ry. station	
Tupelo Springs	Clark	......	Ry. station	
Turin	Grant	......		
Turner	Phillips	......		
Turner	Johnson	390.40	Ry. station	Spirit level.
Turnip	White	......		
Two Bayou	Ouachita	84.80	Bottom of creek, Camden & Alex. Ry. bridge.	Spirit level.

Place.	County.	Elevation.	Point.	How determined.
Tyler	Cleburne	675	Post-office	Aneroid.
Tyner	Phillips	......	......	
Tyro	Lincoln	......	......	
Tyrone	Jefferson	......	......	
Tyronza	Cross	229.10	Ry. station	Spirit level.
Ulm	Prairie	......	Ry. station	
Ultima Thule	Sevier	......	......	
Umpire	Howard	......	......	
Union	Fulton	......	......	
Uniontown	Crawford	860	Post-office	Aneroid.
Upper Ferry	Cleburne	350	Ford of Lit. Red River	Aneroid
Ussery	Garland	......	......	
Vaden	Clark	......	......	
Valley	Hot Spring	......	......	
Valley Springs	Boone	1075	Valley Springs Hotel	Aneroid.
Vallier	Arkansas	......	......	
Van Buren	Crawford	405.60	L. R. & F. S. station	Spirit level.
		439.40	Upper Frisco station	Spirit level.
		416.30	Junction	Spirit level.
		412.94	Abutment of bridge	Precise.
Van Duzer	Ouachita	......	......	
Van Dyke	Ouachita	......	......	
Vanndale	Cross	278.60	Ry. station	Spirit level.
Varner	Lincoln	......	Ry. station	
		178.17	Bench-mark	Precise.
Vaucluse	Chicot	......	......	
Vesta	Franklin	508	Post-office	Aneroid.
Victor	Independence	395	Post-office	Aneroid.
Vidette	Fulton	675	Post-office	Aneroid.
Village	Columbia	......	......	
Vilonia	Faulkner	......	......	
Vincent	Crittenden	......	......	
Vineland	Franklin	......	......	
Vineyard	Lee	......	......	
Viney Grove	Washington	......	......	
Viola	Fulton	692	Pickrum S. H.	Aneroid.
Violet	Arkansas	......	......	
Violet Hill	Izard	......	......	
Wabbaseka	Jefferson	204.58	Ry. station	Spirit level.
Waco	Cleburne	500	Post-office	Aneroid.
Wager	Benton	......	......	
Wake	Baxter	......	......	
Walcott	Greene	......	......	
Waldo	Columbia	352	Ry. station	Spirit level.
Waldon	Carroll	976.40	Ry. station	Spirit level.
Waldron	Scott	660	Court House	Spirit level.
Walker	White	......	......	
Walker Mt.	Pope	2150	Summit	Aneroid.
Walker Mt.	Scott	1520	Crest.	Aneroid.
Wallaceburgh	Hempstead	......	Ry. station	
Wallace Knob	Baxter	1201	Summit	Aneroid.
Walnut	Newton	......	......	
Walnut Bayou	Little River	249.90	Bottom of sec. 31, 13 S., 30 W.	Spirit level.
Walnut Bend	Lee	......	......	

Place.	County.	Elevation.	Point.	How determined.
Walnut Grove	Independence			
Walnut Hill	Lafayette			
Walnut Knob	Van Buren	1606	Summit	Barometer.
Walnut Lake	Desha	162.65	Bench-mark	Precise.
Walnut Ridge	Lawrence	270.10	Ry. station	Spirit level.
Walnut Tree	Yell	400	Post-office	Aneroid.
Wampoo	Pulaski	230.88	General level.	Spirit level.
Wanamaker	Faulkner			
Ward	Lonoke	238.10	Ry. station	Spirit level.
Ward's Crossing	Yell	376		Barometer.
Ware	Columbia			
War Eagle Mills	Benton			
Warm Springs	Randolph			
Warren	Bradley	204.70	Ry. station	Spirit level.
Warrenton	Lincoln			
Warsaw	Pulaski	268	Post-office	Aneroid.
Washburn	Sebastian	585	Post-office	Aneroid.
Washington	Hempstead	351.10	Ry. station	Spirit level.
Washington Mt.	Washington	1494	Summit	Aneroid.
Washita	Montgomery			
Watalula	Franklin	670	Resort	Aneroid.
Water Valley	Randolph			
Waters	Montgomery	840	Post-office	Aneroid.
Watkins	Boone	1235	Post-office	Aneroid.
Watson	Desha			
Wattensaw	Lonoke			
Watts	Searcy			
Waveland	Yell	525	Post-office	Aneroid.
Wayne's Landing		238.98	½ mile above store	Spirit level.
Wayside	Hot Spring			
Wayton	Newton			
Webb City	Franklin	570	Village	Aneroid.
Wedington	Washington			
Weiner	Poinsett	247	Ry. station	Spirit level.
Welborne	Conway	314.10	Ry. station	Spirit level
Welch	Montgomery			
Welch's Pottery	Dallas	460	Pottery	Aneroid.
Weldon	Jackson		Ry. station	
Wells Creek	Newton			
Wesley	Madison			
Wesson	Union			
Western Grove (Tight Wad)	Newton	1100	Post-office	Aneroid.
West Fork	Washington	1340.10	Ry. station	Spirit level.
West Memphis	Crittenden	221.10	Ry. station (K. C., S. & M.)	Spirit level
		[illegible]	Ry. station (St. L., I. M. & S.)	Spirit level.
West Point	White		Ry. station	
West Saline River	Howard	231.50	Bottom, sec. 4, 11 S., 28 W.	Spirit level
Westwood	St. Francis			
Whaley	Sharp			
Wheeler	Washington			
Wheeling	Fulton			

Place.	County.	Elevation.	Point.	How determined.
Wheetley	St. Francis	224	Ry. station	Aneroid.
Whelen Springs, Whelen	Clark	248.60	Ry. station	Spirit level.
White Bluff	Jefferson	218.86	Surface Watt's Place	Spirit level.
White Church	Scott	668	Parks Post-office	Barometer.
White Hall	Poinsett	276.60	Ry. station	Spirit level.
Whitener	Madison	.....		
White Oak	Cleveland	......		
White Oak	Franklin	388.10 394.88	Ry. station Bench-mark	Spirit level. Precise
White Oak Mountain	Pope	2000	Summit	Aneroid.
White Oak Mountain	Scott	2250	Summit	Aneroid.
White Oak Chapel	Logan	650		Aneroid.
White River	Desha	......		
White River	Jackson	232.70	Bridge pier main line St.L.,I M.& S.	Spirit level.
White River	White	206.40 179.40	High water. Bald Knob Br. Ry. bdg. Low water	Spirit level. Spirit level.
White Rock	Franklin	......		
Whittington	Garland	525	Post-office	Aneroid.
Wideman	Izard	600	Post-office	Aneroid.
Wiggs	Garland	......		
Wild Cat Shoals	Baxter	440.58	L.bank White River at head of shoals.	Spirit level.
Wild Cherry	Fulton	900	Post-office	Aneroid.
Wiley's Cove	Searcy	1036	Cove	Barometer.
Wilks	Union	......		
Wilkins	Jefferson	208.58	Ry. station	Spirit level.
Wilcockson	Newton	945(?)	Hotel	Aneroid.
Wild Haws Landing	Izard	281.95	White River, right bank opp. ldg.	Spirit level.
Williamette	Jefferson	......		
Williams	Clay	......		
Williamson's Ldg		813 20	Stone mon., White River, left bank.	Spirit level.
Williford	Sharp	319.10	Ry. station	Spirit level.
Willisville	Nevada	......		
Willow	Dallas	375	Post-office	Aneroid.
Willowdale	Pulaski	240		Aneroid.
Willmington Landing	Union	below 80.		Aneroid.
Wilmar	Drew	147.60	Ry. station	Spirit level.
Wilmot	Ashley	115.95	Ry. station	Spirit level.
Wilson	Pike	......		
Wilson's Ford	Cleburne	455		Aneroid.
Wilton	Little River	......		
Winchester	Drew	......	Ry. station	
Winfield	Scott	655	Village	Aneroid.
Wing	Yell	......		
Winnerva	Baxter	.....		
Winona Springs	Carroll	1283	Spring	Aneroid.
Winslow	Washington	1735.40	Ry. station	Spirit level.
Winsted	Sharp	......		
Wirth	Sharp	......		
Wise	Columbia	......		
Witcherville (Salem)	Sebastian	705	Village	Aneroid.

Place.	County.	Elevation.	Point.	How determined.
Witherspoon	Hot Spring	199.10	Ry. station	Spirit level.
Wittsburgh	Cross	230	Village	Aneroid.
Witt's Springs	Searcy	1953 1853	Post-office Sec. 19, 13 N., 17 W.	Barometer. Spirit level.
Wolem	Searcy	690	Village.	Aneroid.
Wolf Bayou	Cleburne	660	Post-office	Aneroid.
Wolf Creek	Pike			
Woolsey (See Pitkin)	Washington	1377.40	Ry. station	Spirit level.
Wooklawn	Nevada			
Woodson	Saline	255	Ry. station	Aneroid.
Woolley	Union			
Wooster	Faulkner	297	Post-office	Aneroid.
Wrightsville	Pulaski	256.85	Ry. station Bench-mark	Spirit level. Precise.
Wyandotte	Hot Spring		Ry. station	
Wyloe	Ouachita			
Wyman	Washington		Ry. station	
Wynne	Cross	249.90	Ry. station.	Spirit level.
Yale	Johnson		Formerly Eubank's Mill	
Yardelle	Newton	950	Post-office	Aneroid.
Yellville	Marion	600	Court House	Aneroid.
Yocum	Carroll	1200+	Post-office	Aneroid.
Yorktown	Lincoln			
Young	Nevada			
Yuba	Cleburne			
Zadock	Johnson			
Zama	Nevada			
Zelkirk	Scott	750		Aneroid
Zenobia (Lillie)	Crawford	425.40	Ry. station.	Spirit level.
Zion	Izard			
Zuber	Saline			

OBSERVATIONS UPON THE EROSION

IN THE

HYDROGRAPHIC BASIN OF THE ARKANSAS RIVER ABOVE LITTLE ROCK.

By JOHN C. BRANNER, State Geologist.

In October, 1887, I began and carried on for one year a series of observations upon the Arkansas River at Little Rock, for the purpose of determining the efficiency of that stream as an agent of erosion and transportation. These observations consisted of a series of thirty-two measurements of discharge, three hundred and sixty-five gage readings, one hundred and seventy-nine determinations of matter carried in suspension, and a similar number of determinations of matter carried in solution by the river water. These observations were so distributed as to be as comprehensive as possible, embracing all the varying conditions of weather, temperature and rainfall; when the river was rising, when it was falling, when at a standstill; when low, when high, and whenever there was any considerable change in the volume or character of the water.*

Method of observation.†—A cross section was carefully measured 1,200 feet above the upper bridge, a place in the river where there was least chance of any marked change occurring within the time occupied by the observations. At the place selected one bank is of rock and the other of tough clay.

*This paper deals only with such conditions and changes as are possible in a given section; it does not consider the effects of curves or varying depths of the channel.

†The field observations were entrusted to Assistant Chas. E. Taft, an able civil engineer of wide experience.

Floats were sent through this section at transverse intervals of twenty-five to fifty feet, and their positions as they crossed the section were located by a transit, and the time occupied in floating one hundred feet was noted. Wooden rods twelve feet in length were used as floats. These rods were two inches square at one end, from which they tapered the whole length of the rod to a sharp point at the other. They were weighted so as to float upright and to leave the pointed end about two feet out of the water to serve as a signal. Where the rods could not be used on account of shallow water, a surface float with a weight attached by a cord was substituted. From the data thus obtained the volume of the river was deduced. Sets of samples of the water were taken along the cross-section at the time of the velocity observation, each set being in three parts, one each from the surface, mid-depth, and three feet from the bottom. In collecting the sample from the bottom, in order to avoid taking it from the liquid mud usually present next to the bottom, the collecting apparatus was so arranged that the sample was taken three feet from the actual bed of the stream. In order to avoid the possible mingling of the water from lower depths with that above, and to insure that the samples fairly represented the part of the stream from which it was taken, an open glass tube holding one litre was used for a collecting vessel. This was so arranged as to close securely by means of two rubber balls. When a sample was to be taken, the stoppers were caught back, leaving the ends of the tube entirely unobstructed; the tube was then sunk by means of a rod, care being taken to keep its axis parallel with the current of the stream. By means of a gage the depth to which it was desired to sink it was determined. When the vessel reached the desired point, a jerk of the string released the rubber balls, which closed the ends of the tube and confined in it a representative of the part of the stream from which it was taken. The samples were always taken at the time the volume of the stream was being measured. They were placed in separate, clean bottles for examination.

In order to determine the amount of matter carried in me-

chanical suspension these samples were all taken to the laboratory and filtered until the water was perfectly clear; the filter containing the suspended matter was then dried, and weighed at the temperature at which it had previously been weighed. The amount of matter in solution was determined by evaporating the filtered water. These determinations were made for every sample collected during the year—358 determinations.* A daily record was also kept of the stage of the river during the time covered by the investigation.

These observations furnish data for the approximate determination of the discharge of the Arkansas River, and of the amount of material carried by it, both in suspension and solution, past Little Rock, during the year in which the observations were made (1887–8).

Suspended matter.—The color of the water of the Arkansas River is due to mineral matter carried in mechanical suspension. It is more or less muddy all the year round, and even at its lowest stages, when it carries least sediment, it is not quite clear. Its color is ordinarily a yellowish brown, but it sometimes becomes dark red, at which times it carries such a large amount of mechanical sediments as to render it opaque, even as seen in an ordinary test tube.

The laws of erosion and transportation naturally lead one to expect a large amount of mechanical sediments to be removed when the volume of water or discharge is greatest. If the conditions which supply sediments to the stream were constant, this would undoubtedly be true, but the conditions are not constant, and the amount of material moved depends upon the sediment-supplying conditions rather than upon the transporting power of the water.

The matter in suspension is greatest during a sudden high rise; but after the water in the stream stands at any high mark for a few days, the decrease of the amount of suspended matter it carries is very marked. The amount of sediment

*The laboratory determinations were made under my personal direction by Dr. R. N. Beackett. All the care required by quantitative chemical analyses was taken with this work.

carried by the river varies widely also with the same gage reading at any stage, being greater with a rising, and less with a falling river. This contrast is most noticeable during the winter, propably because the frosts and other weathering agencies loosen up the surface soil and leave it in a condition favorable for ready transportation.

The lowest stages of the river are usually during the latter part of the summer and in the fall of the year. At such times the water becomes nearly but not quite clear. This clearness is due partly to a decrease in the volume and consequently in the velocity and carrying power of the water, and also to the large amount of common salt, lime, etc., in solution in the water, which substances tend to flocculate and precipitate the mechanical sediments. The greatest amount of mechanical sediment found in the water during the year under consideration was 225 grains to the U. S. gallon*; this was on the second of May, 1888, when the river stood at seventeen feet on the gage, and shortly after protracted rains over the whole or nearly all the hydrographic basin of the Arkansas River above Little Rock. It should be added, however, that while this high water may be taken as a type of the ordinary rises, there are times when there is but little or no rise, no increase in the volume of water discharged, but a very marked increase in the amount of mechanically suspended matter. In October, 1891, occurred one of these so-called "red rises" of the Arkansas River, and although the river was quite low—marking only 3.9 feet on the gage—it carried out 761 grains of matter to the gallon, of which only 48 grains was matter in solution. Such a condition of the water is said to be due to rainfalls on the Canadian River, an affluent of the Arkansas, which runs through the "red beds" of western Indian Territory. This illustrates well the fact to which attention has already been called† that the sediments removed bear no constant relation to the discharge.

*The gallon referred to in this paper is the U. S. gallon of 58,372.175 grains or 231 cubic inches.

†Annual Report, Chief of Engineers, U. S. A., 1874, I, p. 863; 1875, I, p. 966; 1877, I, p. 433; Physics and Hydraulics of the Miss. River, 1876, p. 417.

The total amount of suspended matter estimated by the above methods to have been carried down by the Arkansas in 1887–8 was 21,471,578 tons.* This estimate, however, must be regarded as far short of the truth, for the method of taking the water samples has left out of account that stream of almost liquid mud and sand that is pushed along the bed of the river at all stages, but especially during high water, and which adds enormously to the amount of material daily and hourly carried out of the hydrographic basin of the Arkansas River above Little Rock.†

Character of the sediments.—The matter in mechanical suspension in the river water is both sand and clay. Samples taken from the thread of the stream are mainly of fine sand, but samples of sediments allowed to settle in the quiet eddies of the river show that the lighter and more flocculent sediments sink to the bottom only in the quiet portions of the water.

An analysis was made of the sediments collected in six samples of river water of the 11th of April, 1888, two each from top, middle, and bottom of the stream.

ARKANSAS RIVER SEDIMENT FROM THE STREAM ‡

Sand and insoluble matter	85.18 per cent.
Soluble matter	14.82 " "

The soluble portion contained:

Iron oxide (Fe_2O_3) Alumina (Al_2O_3)	4.96 per cent.

On this occasion the river was very high, standing at 17 feet on the gage, but it had been higher by half a foot two days before.

*The tons used in these computations are the short tons of 2000 pounds.

†In the Annual report of the Chief of Engineers, U. S. A., 1875, II, p. 478, Col. J. H. Simpson shows how sand-bars travel down-stream. See also Physics and Hydraulics of the Miss. River, by Humphreys and Abbot, 1876, pp. 147–8. Dana says that Forshey estimates the silt pushed along by the Mississippi River at three times that held in suspension, instead of one-ninth as estimated by Humphreys and Abbot. (Dana's Manual of Geology, 3d ed. p. 657). Prof. Forshey is now dead and I have not been able to learn upon what his estimate is based. The estimates of Humphreys and Abbot do not take this material into account.

‡Analysis by Dr. Jas. Perrin Smith.

A complete analysis was made of the sediment collected with six litres of water, May, 2d, 1888, when the river stood at 17 feet on the gage after a sudden rise, and while the rise was still in progress. It is as follows:

ANALYSIS OF ARKANSAS RIVER SEDIMENT.*

	Per cent.
Silica (SiO_2)	69.53
Alumina (Al_2O_3)	11.65
Iron (ferric oxide Fe_2O_3)	4.46
Carbonate of lime ($CaCo_3$)	6 62
Carbonate of magnesium ($MgCo_3$)	3.52
Potash (K_2O)	.66
Soda (Na_2O)	1.14
Organic and volatile matter	2.95
Total	100.58

These analyses, together with a large number of washings of the sediment, show that its chief constituent is quartz sand. There is always more or less clay in the water.

The finer sediments.—Experiments have already been made by other observers which show that extremely fine material held in suspension by water may be retained in suspension for an indefinite length of time.† The observations upon Arkansas River water point to the same conclusion. A glass jar one metre in length and holding six litres, was filled with turbid water taken from the river October 10th, 1887, and was allowed to stand in the Survey office until January 16th, 1888. Within four days after it was filled the water had become comparatively clear. Very fine particles continued, however, to float about in it until January 15th. That night the weather was cold enough to freeze and feathery ice crystals penetrated the whole body of the water. As soon as the room was warmed and the ice melted, the matter in suspension collected in masses resembling strings of cobwebs, in which form it clung

*Analysis by Dr. Jas. Perrin Smith.

†On the subsidence of particles in liquids, by Prof. Wm. H. Brewer, Memoirs Nat. Acad. Sci., Vol. II, p. 165.

Subsidence of fine solid particles in liquids, by Carl Barus, U. S. Geological Survey, Bulletin 36, 1886.

to the sides of the jar or sank to the bottom, leaving the water perfectly clear.

Dissolved matter.—The matter in solution bears no constant relation to the volume of water, though in a very general way it varies inversely with the volume of the water, and ranges from 11 to 70 grains to the U. S. gallon. This dissolved matter is principally chlorides of sodium, potassium, and magnesium, and the carbonates of lime, soda, and magnesia. At low stages of the river there is enough sodium chloride in the water to give it a decidedly brackish taste. The analyses given below represent high and low stages of the water.

ANALYSIS OF FILTERED ARKANSAS RIVER WATER.

(Sample collected December 20th, 1888, when the river stood at nine feet on the gage).

Hypothetical Combination.

		Grains per U. S. Gallons.	Per cent. of Solids.
Silica	(SiO_2)	.75	11.81
Chloride of sodium	($NaCl$)	1.96	30.87
Chloride of potassium	(KCl)	.44	6.93
Sulphate of magnesium	($MgSO_4$)	.14	2.20
Sulphate of Iron	($FeSO_4$)	.43	6.77
Sulphate of alumina	($Al_2(SO_4)_3$)	.15	2.36
Carbonate of soda	(Na_2CO_3)	1.07	16.85
Carbonate of magnesia	($MgCO_3$)	.28	4.41
Carbonate of lime	($CaCO_3$)	1.13	17.80
Total		6.35	100.00

Found.

Silica	(SiO_2)	.75	11.83
Sulphuric acid	(SO_4)	.51	8.04
Carbonic acid	(CO_3)	1.48	23.34
Chlorine	(Cl)	1.39	21.92
Iron	(Fe)	.16	2.52
Aluminum	(Al)	.02	.32
Calcium	(Ca)	.45	7.10
Magnesium	(Mg)	.11	1.73
Potassium	(K)	.23	3 63
Sodium	(Na)	1.24	19.57
Total		6.35	100.00

ANALYSIS OF FILTERED ARKANSAS RIVER WATER, LOW STAGE.

(Sample collected August 22d, 1888, when the river stood at 2.4 feet on the gage).

Hypothetical Combination.

		Grains per U. S. Gallons.	Per cent. of Solids.
Silica	(SiO_2)	.85	1.83
Chloride of sodium	($NaCl$)	28.57	61.58
Chloride of potassium	(KCl)	.68	1.47
Sulphate of magnesia	($MgSO_4$)	3.92	8.45
Sulphate of lime	($CaSO_4$)	.75	1.62
Sulphate of iron	($FeSO_4$)	.05	.11
Sulphate of Alumina	($Al_2(SO_4)_3$)	.38	.82
Carbonate of lime	($CaCO_3$)	8.47	18.26
Total		46.36	100.00

Found.

		Grains per U. S. Gallons.	Per cent. of Solids.
Silica	(SiO_2)	.85	1.83
Sulphuric acid	(SO_4)	5.90	12.73
Carbonic acid	(CO_3)	5.08	10.96
Chlorine	(Cl)	17.62	38.91
Iron	(Fe)	.02	.04
Aluminum	(Al)	.06	.13
Calcium	(Ca)	3.56	7.68
Magnesium	(Mg)	.78	1.68
Potassium	(K)	.35	.75
Sodium	(Na)	12.14	26.15
Total		46.36	100.00

It will be noticed that at the low stage of water 61.57 per cent. of the dissolved matter removed is common salt, and 8 per cent. is Epsom salt.

This dissolved matter is invisible and consequently not of a kind to attract so much attention as the mechanical sediments, but the total for a day, a month, or a year, is an impressive one. The amount carried down in this form from October, 1887, to September, 1888, was 6,828,350 tons, and averaged 569,029 tons per month; during the single month of May, 1888, 1,161,160 tons were carried out in solution. When it is remembered that this material has all been dissolved from hard rocks within the drainage basin of the Arkansas River

some conception can be had of the importance of this method of land degradation.*

The relation existing between the matter in solution and that in suspension is what one would naturally expect, viz.: when the river is high there is least dissolved and most suspended matter to the gallon of water, and *vice versa*. This, however, must be regarded as a very general rule to which there are many and important exceptions. The results for the month of April, 1888, will serve as an example of these relations.

During that month eight sets of observations were made with the following results:

TABLE SHOWING THE FLUCTUATING RELATIONS OF SUSPENDED TO DISSOLVED MATTER.

DATE, 1888.	Gage, ft.	Dis. cu. ft. per sec.	Grs. pr. U. S. gal.		Tons per day.		Total tons per day.
			Suspended.	Dissolved.	Suspended.	Dissolved.	
April 9.	5.75	19,608	29.41	15.41	26,619.1	13.947.7	40.666.8
" 13.	13.65	62,128	85.60	11.00	235,486.1	31,546.1	267,032.2
" 14.	16.30	92,199	122.50	13.60	519,858.9	59,880.3	579,739.2
" 16.	17.00	98,233	174.30	15.30	793,852.0	68,176.8	862,028.8
" 18.	13.35	65,512	112.60	15.70	340.517.5	47.478.9	387,996.4
" 21.	10.70	38,365	58.50	15.00	103,595.8	26,563.0	130,158.8
" 25.	6.20	17,627	45.17	43.76	36.753.1	35.605.9	102,459.0
" 28.	5.50	16,214	31.83	42.53	23,822.8	31,831.1	55.653.9

*But little attention has been given to the determination of mineral matter removed in solution from the land. The observations of hydraulic engineers to whom we are indebted for the determination of mechanical sediments, have not usually included the discharge of matter in solution, for the reason, no doubt, that they have had to deal practically and principally with the mechanical sediments only. Determinations of dissolved matter in river waters are given by Bischof (Chemical Geology, I, 75-79), Prestwich (Quar. Jour. Geol. Soc. 1872, LXVI), Geikie (Text-Book of Geology, 2nd Ed., 353), and by T. Mellard Reade (Chemical Denudation in Relation to Geological Time, London 1879). The estimates of these writers, however, all appear to be based upon a limited number of determinations.

Taking the observations for the entire year under consideration, *the matter in solution is equal to about .31 of that in suspension, or a little more than one-fourth of the total amount removed.* These relations, however, are not constant, as may be seen by a comparison of the totals in suspension and solution during the individual months or on individual days. In November, 1887, for example, the dissolved matter was greatly in excess of the suspended matter—more than six times as much—while on October 13th, 1891, the suspended matter was more than thirteen times the matter in solution.

T. Mellard Reade* speaks of the constancy of the matter removed in solution by streams. However true such a generalization may be for the Thames, this series of observations shows clearly enough that it is not true of all streams. The smallest amount of matter was found in the Arkansas water April 13, 1888, when it held 11 grains to the U. S. gallon; on the 18th of August of that year it contained 71.8 grains to the U. S. gallon. The fluctuation in the Thames water on the other hand varies, according to Prestwich, between 14.93 and 19.23 grains per U. S. gallon.†

This difference in the fluctuation of the dissolved matter carried by the two streams is probably due to the fact that the Thames drains a region of limestones and limestone soils, so that whether its waters come from the surface or from springs they flow in either case over the same kind of rock. The Arkansas on the other hand drains a basin mostly of sandstones

*Chemical Denudation in Relation to Geological Time, by T. Mellard Reade, London, 1879, p. 24.

†Reduced from Prestwich, Geology I. 107. Bischof in his Chemical Geology, I. 76, gives nine analyses of Thames water, one of which shows 23.22 grains per U. S. gallon.

and shales from which only underground waters are able to remove much lime.*

Attention is called to the larger percentage of silica in the water in times of freshets; 1.83 of the total at low water, and 11.81 of the total at high water.† The water at low gage readings is all spring water, or water that has passed through the rocks or soils instead of over them, while that at high readings is chiefly surface water. It seems probable, therefore, that the silica exposed over the surface of the ground is rendered more soluble by its exposure to weathering influences and to the organic acids of decaying organic matter, than is that of the unexposed rocks through and over which underground waters pass.

The results.—The following tables are based upon gage readings for every day of the year, a complete set of velocity and discharge observations made and comprehensive samples of water collected on 32 days. From these observations interpolations were made to complete the table. The results of two independent sets of interpolations agree so closely that they may be regarded as practically the same.

*In order that the results obtained for the Arkansas may be compared with the rates of chemical denudation of other hydrographic basins the estimates given by Reade are quoted here.

Rates of chemical denudation by various streams.

Stream.	Dissolved matter removed per square mile.
Rhone	232.0 long tons per year.
Thames	149.0 " " " "
Garonne	142.0 " " " "
Seine	97.0 " " " "
Rhine	92.3 " " " "
Danube	72.7 " " " "
Arkansas	43.5 " " " "

†Inasmuch as only one pair of analyses was made to determine this point it is possible that a generalization on this subject is not to be trusted, in any case it is desirable that other observations be made on this subject.

MATERIAL CARRIED BY THE ARKANSAS RIVER PAST LITTLE ROCK DURING THE YEAR 1887–8.

1887.	Tons in Suspension.	Tons in Solution.	Tons in Suspension and Solution.
October	377,557.2	354,171.9	731,729.1
November	16,449.9	102,082.4	118,532.3
December	700,558.2	444,062.5	1,144,620.7
1888.			
January	230,400.4	481,925.9	712,326.3
February	999,398.0	468,320.5	1,467,718.5
March	2,391,281.0	666,753.5	3,058,034.5
April	4,381,629.2	818 474 6	5,200,103.8
May	6,208,717.0	1,161,160.0	7,369,877.0
June	4,467,377.4	860,214.0	5,327,591.4
July	296,234.2	499,869.2	796,103 4
August	121 955.5	383,369.5	505,324.0
September	1,280,020.6	577,946.4	1,857,967.0
	21,471,578.	6,828,350.	28,299,929.

The total bulk of this material would make a cube whose sides would be 749.2 feet in length.* The total suspended

*The specific gravity of the suspended matter is assumed to be 2 13—an assumption based upon an average of seven determinations of the specific gravity of Arkansas River sediments. It is worthy of note that six of the samples used in these determinations were taken from sediments deposited naturally along the river, and one of them was taken from the water used in making the laboratory determinations on sediments. The specific gravity here used is therefore somewhat too high. See also Humphreys and Abbot, p. 140

DETERMINATIONS OF SPECIFC GRAVITY OF ARKANSAS RIVER SEDIMENTS.

No. 1.—Sp. gr. 1.7921. Collected Nov. 13, 1888, about 40 feet east of the St. Louis, Iron Mountain and Southern Railway bridge (upper bridge) on the north bank of the river within a few feet of the water's edge.

No. 2. Sp. gr. 1.7764. Collected Nov. 13, 1888, about 100 feet east of the St. Louis, Iron Mountain and Southern Railway bridge, on the north bank of the river.

No. 3.—Sp. gr. 1.8043. Collected Nov. 13, 1888, about 40 feet west of the St. Louis, Iron Mountain and Southern Railway bridge, on the north bank of the river.

No. 4.—Sp. gr. 1.8014. Collected Nov. 13, 1888, about 100 feet west of the St. Louis, Iron Mountain and Southern Railway bridge, on the north bank of the river.

No. 5.—Sp. gr. 1.8090. Collected at the foot of Spring St. on the south bank of the river. A cube of 21.9 grams was dried at 120° C., and allowed to stand several days in the air.

No. 6.—Sp. gr. 1.17603. Collected Nov. 13, 1888, about 15 feet east of the St.

matter, if spread over the hydrographic basin of the Arkansas River above Little Rock—140,000 square miles*—would have a thickness of .000,082 of a foot; the total dissolved matter would have a thickness of .000,024 of a foot, or the total suspended and dissolved matter would be .000,106 of a foot in thickness. Erosion over this area during the year 1887–8 therefore took place at the rate of one foot in 9433 years.†

The interpolations made in the observations on sediments discharged, necessarily detract from the value of the conclusions reached in regard to the quantity of material carried out of the basin. These conclusions must, therefore, be accepted only with the confidence to which the methods followed in the work entitle them. The means at the command of the Geological Survey did not permit the exhaustive observations that were desirable; indeed, that a thoroughly satisfactory set of observations should be made with the modest appropriation of a state Geological Survey is quite out of the question. The observations have some value, however, on account of their never having been made at this point‡ before, and it is hoped that no apology is necessary for their publication. But whether the work had been thoroughly comprehensive or not, it is evi-

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Louis, Iron Mountain and Southern Railway bridge, on the south bank of the river.

Nos. 1, 2, 3, 4, and 6 were air-dried.

No. 7.—Sp. gr. 2.5632. A mixture of the sediment from six bottles of water collected for sediment determinations, May 2, 1888.

The specific gravity of the dissolved matter is assigned it from the specific gravities of the constituents (in their proper proportions) found by analyzing the filtered water.

*The area of the hydrographic basin above Little Rock was kindly furnished by Henry Gannett, of the U. S. Geological Survey. Other estimates make it somewhat larger.

‡Attention should again be directed to the fact that no account is here taken of silts pushed along the bed of the stream. See foot note on p. 157.

‡The investigations of Humphreys and Abbot include a series of discharge and current measurements on the Arkansas River at Napoleon. As those authors point out, however, (Physics and Hydraulics of the Miss. River, 1876, pp. 33, 84) the water of White River was included in their measurements, although that stream can scarcely be regarded as a tributary of the Arkansas. Their results must have been considerably modified by the presence of so large a body of comparatively clear water.

dent from the behavior of this large stream, fed from such a large and geologically diversified hydrographic basin, that slight and even local changes of meteorologic conditions may greatly change the results obtained, or those that would have been obtained, had a complete set of observations been made daily instead of occasionally. The total here given for the year 1887-8 may be twice as large or but half as large as that for the next succeeding year even with the same or nearly the same discharge of water. For this reason no estimate of results for a longer period based upon these observations, or estimate for any other period of time, can be more than approximately correct, because the relations of the amount of matter carried either in solution or suspension to the volume of water are not constant. A perfectly satisfactory measure of the actual work done by such a stream can only be determined by a series of observations upon sediments and dissolved matter covering a number of years, and made in connection with careful meteorologic observations during the same period over the entire hydrographic basin. It is also evident that deductions derived from observations upon the Arkansas River are not applicable to the study of other streams except in a very general way.

MAGNETIC OBSERVATIONS AND MERIDIAN MONUMENTS ESTABLISHED IN ARKANSAS.

It was hoped at one time that the Geological Survey might be able, during the progress of its work, to make a magnetic survey of the State, and to set upon the true meridian at every county seat a pair of permanent stone monuments.

Such a work would be useful to surveyors and in settling disputes that arise or are liable to arise concerning "the variation of the compass" in making land surveys, and would at the same time be an important contribution to our own and to the world's knowledge of the earth's magnetism.

The lack of funds to pay for stone monuments to permantly mark the meridian and to pay the traveling expenses of the assistant doing the work and the lack of time in which to do it have prevented its being done by this Survey. A beginning was made, however, in 1888, and the meridian was permantly marked at a few places where public spirited citizens kindly furnished the stone monuments necessary for the purpose. The Survey was not provided with the best instruments for the work, but the few results obtained are given here for what they are worth.

The determinations were made in each case by observations upon the elongation of Polaris. With the exception of those made at Fayetteville, Washington county, and at Magnet Cove, these observations were made by my assistant, Mr. Charles E. Taft, with a Heller and Brightly mountain transit having a three inch needle.

Below is a list of the localities at which observations were made and descriptions with figures showing the exact positions

of the monuments which will enable anyone to find them without difficulty. The places are named in alphabetical order.

8° EAST. *Charleston, Franklin county.*— At Charleston two stone monuments in the court-house yard are buried three feet and project six inches from the ground. The top face of each monument is six inches square, and has a centre point of fine brass wire set in lead. The monuments are about 142 feet apart, and the south monument is about 48 feet north from the north entrance of the school house. The magnetic variation at this meridian at 9 A. M., December 22nd., 1888, was 8° East.

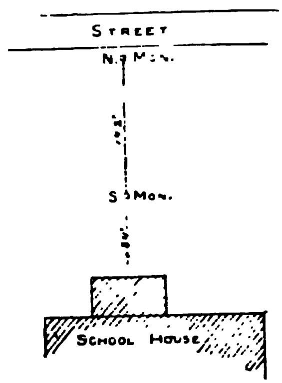


FIGURE 1. *The positions of the meridian monuments at Charleston.*

7° EAST. *Clarendon, Monroe county.*—Two stone monuments in the court-house yard at Clarendon are buried three feet and project eight inches. They are 99 feet apart, and a line between them is 30 feet west from the southwest corner of the court-house. The top face of each monument is six inches square, and has a centre point of fine copper wire set in lead. The magnetic variation by this meridian at 9 A. M., December 5th., 1888, was 7° East.

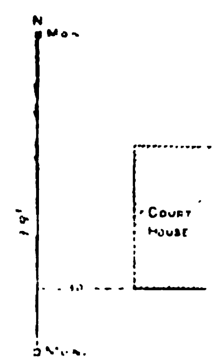


FIGURE 2. *The positions of the meridian monuments at Clarendon.*

7° 20′ EAST. *Clarksville, Johnson county.*—Two stone monuments in the court-house yard are set upon the Clarksville meridian. The top face of each is six inches square, and has a centre point of brass wire set in lead. The south monument is eight feet north of the south line of the court-house yard, the north monument is ten feet south of the north line of the court-house yard. The monuments are about 140 feet apart and a line drawn between them is about nineteen feet from the north-east corner of the court-house. The magnetic variation by this meridian at 10 A. M., December 28th., 1888, was 7° 20′ East.

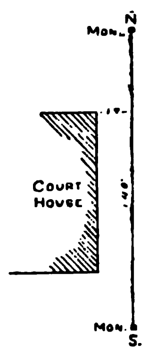


FIGURE 3. *The positions of the meridian monuments at Clarksville.*

8° EAST. *Fayetteville, Washington county.*—Two sandstone posts with copper centre points imbedded in lead were planted in the court-house yard as shown in the figure below. The instrument used was a Gurley transit having a five inch needle. The observations were made on the western elongation of Polaris on the night of December 21, 1888. The telescope was plunged and reversed for several successive sights, in order to eliminate any error in collimation, and the mean of the observations was taken as the true line.

Observations from different points in the yard of the court-house showed local attraction. To get rid of this a vernier line was run down Block street about 200 feet from the square to a point where there seemed to be no local attraction.

At the south post the variation of the needle is 9° 10′ East, of which 1° 10′ is local and must be substracted. At the north

post it is 7° 50′ East, of which 10, is local and this must be added to the 7° 50′ to obtain the true declination at any time. The Fayetteville observations were made by assistant Arthur Winslow.

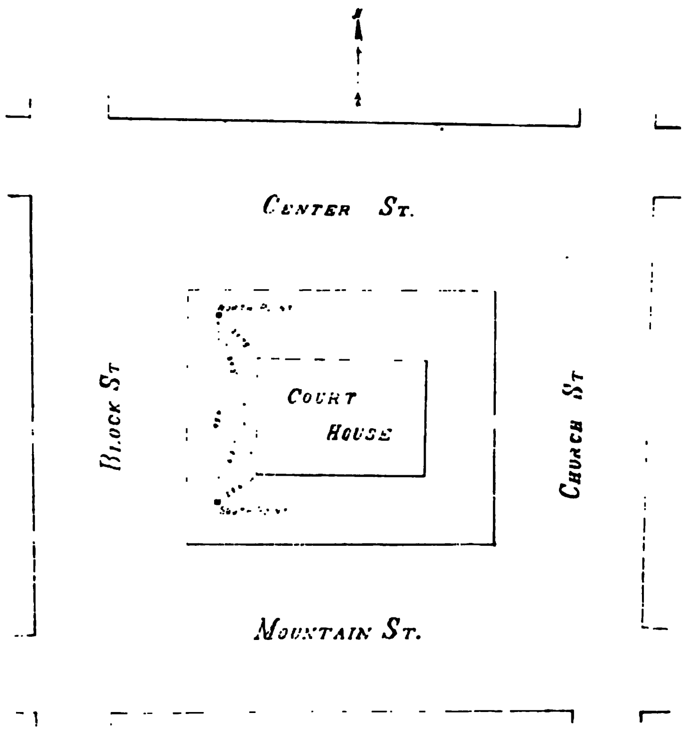


FIGURE 4. *The positions of the meridian monuments at Fayetteville.*

6° 15′ EAST. *Forrest City, St. Francis county.*—The variation at 9 A. M., November 24th., 1888, was 6° 15′ East. The stones for permanent record not being ready, two stakes were driven in the ground about 125 feet apart, with a small tack in the head of each. A line drawn through both tacks is the true meridian. The stakes are 400 feet west of the school-house, on the north side of the street.

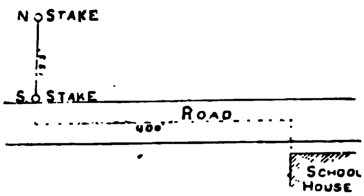


FIGURE 5. *The positions of the meridian monuments at Forrest City.*

8° 25′ EAST. *Fort Smith, Sebastian county.*—At Fort Smith there are two stone monuments in the park that is bounded on the north by Sullivan street, south by Cabell street, east by Mayer street, and west by Beckle street. The monuments are buried three feet and project one foot from the ground. The top face of each monument is seven inches square, and has a centre point of fine brass wire set in lead. The monuments are about 362 feet apart, the north monument is about 112 feet south from the south line of Sullivan street, and about 230 feet west from the west line of Mayer street. The magnetic variation at this meridian at 9 A. M., December 19th., 1888, was 8° 25′ East.

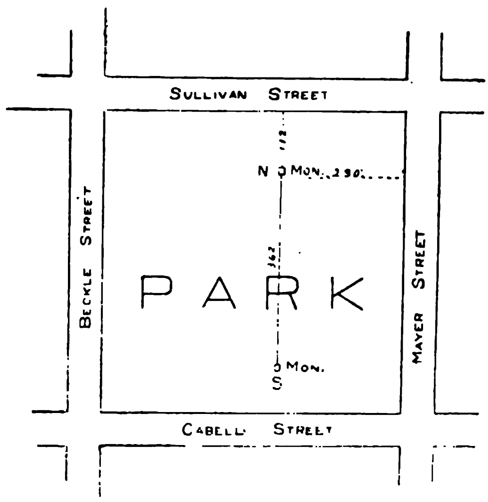


FIGURE 6. *The positions of the meridian monuments at Fort Smith.*

7° 50′ EAST. *Greenwood, Sebastian county.*—Two stone monuments in the court-house yard at Greenwood are buried three

feet and project one foot above the ground. The top face of each monument is six inches square and has a centre point of fine brass wire set in lead. The monuments are about 112 feet apart, and a line joining them is about 24 feet east from the east door of the court-house. The north monument is about 8 feet south from the north side of the court-house yard. The magnetic variation by this meridian at 9 A. M., December 21st., 1888, was 7° 50′ East.

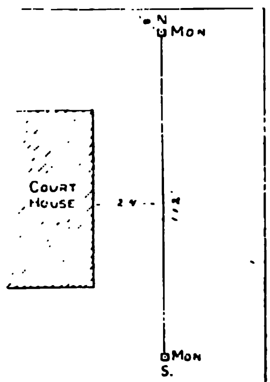


FIGURE 7. *The positions of the meridian monuments at Greenwood.*

6° 12′ EAST. *Helena, Phillips county.*—The stone monuments in the court-house yard at Helena are buried three feet and project eight inches above the ground. The monuments are about 207 feet apart and thirty feet west of the east line of the yard. The top face of each monument is six inches square and has a centre point of fine copper wire set in lead. The magnetic variation by this meridian at 9 A. M., December 3rd., 1888, was 6° 12′ East.

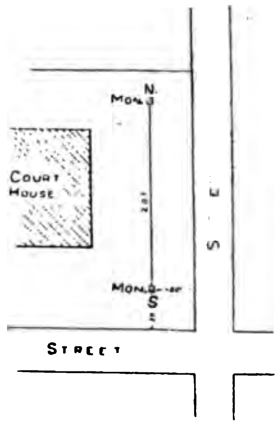


FIGURE 8. *The positions of the meridian monuments at Helena.*

7° EAST. *Lonoke, Lonoke county.*—The two stone monuments in the court-house yard at Lonoke are buried three feet and project one foot. They are about 105 feet apart, and the meridian line is 33 feet west from the court-house front door. The top face of each monument is seven inches square and has a centre point of fine copper wire set in lead. The magnetic variation by this meridian at 9 A. M., December 7th., 1888, was 7° East.

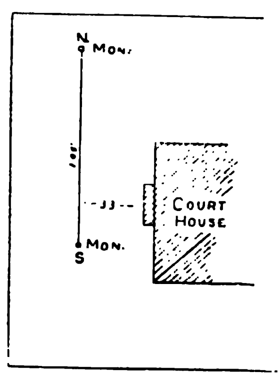


FIGURE 9. *The positions of the meridian monuments at Lonoke.*

15° 15′ EAST. *Magnet Cove, Hot Spring county.*—Two rough stone monuments were planted in the open field in the valley near the road on the east side of Cove Creek about 400 yards

west of John F. Moore's house, and on the north side of the Magnet Cove—Hot Springs Road. The declination at this station at 8 A. M., April 10th., 1888, was 15° 15′ East.

The great local variations in and about Magnet Cove made compass surveying untrustworthy, and the topographic map of the Cove made by the Geological Survey was therefore based upon a series of traverse lines. During the progress of the work observations of magnetic disturbances were made at several places in the Cove. The compass needle varied all the way from 44° East to 6′ West of the true meridian. The last mentioned observation was made at the Methodist Church east of the Cove, the former was made in the highly disturbed area in section 13 on the Hot Springs wagon road. The line of no variation passes just west of the Methodist Church.

Except that at the initial point, these determinations were made by Mr. W. J. Hutcherson in 1888.

During the progress of his work upon the Igneous Rocks of Magnet Cove Dr. J. Francis Williams became interested in the magnetic disturbances in that region and made a number of observations the principal results of which are given here.*

"From the personal observations of the writer and from readings taken by Mr. W. J. Hutcherson, the topographer who made the contour map of Magnet Cove, * * * * it has been found that on the bed of magnetic iron ore the compass is of no use whatever. An engineer's transit, with a short needle, was set up on the top of the hill (N. E. corner of N. W. ¼ of S. W. ¼ of section 20, 3 S., 17 W.), and a stake about two hundred yards west was taken as a point at which to sight. The bearing was taken and the transit was moved ten feet further east and the bearing taken again. A difference of 13° 30′ in the bearing of the stake was observed. The transit was then placed fifteen feet south of the original point and a difference of 15° was found to exist between the bearings of the stake taken from that point and the original station. This

*Annual Report of the Geological Survey of Arkansas for 1890, Vol. II., pp. 170–173 with isogonic chart of Magnet Cove.

shows conclusively that no reliance can be placed upon compass readings on or near the loadstone region.

"The normal amount of the magnetic declination as determined by the position of Magnet Cove with reference to the general isogonic lines of the state would be about 8°* east in 1890. It will be seen, however, by an inspection of the isogonic chart (Plate 13) that, about half a mile east of the magnet ore bed the declination becomes zero and the needle points due north, while at a somewhat greater distance west of the same point the normal declination is nearly doubled. It is evident, therefore, that the effect of the magnetic force centered in this ore bed amounts to about 8° and that this extends to a distance of about a mile west and half a mile east of the distributing area.

"On the western side of Magnet Cove an area of still greater magnetic declination occurs. Here the variation is due to quantities of fine magnetic sand which, although apparently entirely superficial, exerts a great influence upon the needle. Its maximum effect is at a point about half a mile west of the school-house on the hill (centre of section 24, 3 S., 18 W., near the north line) and amounts to about 44°. The isogonic lines here come so near together and are so uncertain in their positions that but little reliance can be placed upon them.

"There is another strongly disturbed region at the northeast corner of the area included in the chart. In this case the cause of the disturbance is a mass of lodestone quite similar in character to that in the centre of the Cove. This deposit is much smaller than the 'lodestone bed' and less of the ore appears on the surface. It is evident, however, that it is present in sufficient quantities to have a strong influence upon the bearing of the magnetic needle."

6° 20′ EAST. *Marianna, Lee county.*—Two stone monuments

*See Report of the Supt. of the U. S. Coast and Geodetic Survey for 1889. Washington, 1890, Appendix No. 11, 1889. "The distribution of the magnetic declination in the United States for the epoch 1890." By Charles A. Schott, p. 246. See also the observations on magnetic declination made by the Geological Survey of Arkansas and recorded in the annual report for 1891.

were planted in the school-yard, buried three feet and projecting three inches from the ground. They are about 125 feet apart and twenty feet west of the east side of the school-yard. The top face of each monument is six inches square and has a centre point of fine brass wire set in lead. The magnetic variation by this meridian at 9 A. M., November 28th., 1888, was 6° 20′ East.

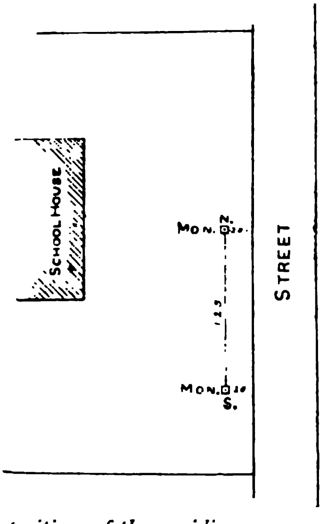


FIGURE 10. *The positions of the meridian monuments at Marianna.*

A PRELIMINARY LIST

OF THE

MOLLUSCA OF ARKANSAS.

(Exclusive of the Unionidæ.)

BY F. A. SAMPSON, A. M.,
Sedalia, Missouri.

INTRODUCTION.

In the effort to work up the natural history of Arkansas the Geological Survey was fortunate enough to induce Mr. F. A. Sampson, of Sedalia, Missouri, to undertake the preparation of a list of the Mollusca. Mr. Sampson is better acquainted with the Mollusca of the State than any one else, for besides having collected here for many years, his acquaintance with the physical features of the State, and with local collectors has enabled him to get together the best collection of Arkansas shells thus far made.

Mr. Sampson published an article upon Arkansas Shells, with a list, in the Kansas City *Review of Science* for May, 1883, and also in the *American Naturalist* for January, 1887. Since those articles were published he has done considerable collecting and has been able to extend the number of species found. The present list, however, must still be regarded as preliminary, for a complete list can be made only after long and careful search in all parts of the State.

In the present paper the land shells are arranged according to Binney's latest work, and the other shells are generally arranged according to the Smithsonian publications.

The Binney collection referred to is that of W. G. Binney, donated by him to the National Museum.

Following the name of each species is a list of the counties in which it has been found, and the number of specimens from that county in Mr. Sampson's Arkansas collection. In many cases the number given is also the total number found in the county.

The authority for the locality is given after the name of the county except in cases where Mr. Sampson himself is the collector, when no name is given.

More species have been found in Carroll than in any other

county—48 exclusive of the Unionidæ, which are not included in this report.

It should be stated in this connection that several years ago Professor R. Ellsworth Call, of Louisville, Kentucky, prepared for this Survey a valuable list and paper upon the Unionidæ of Arkansas, but unfortunately the delay in its publication induced him to withdraw his paper, much to our regret, for publication elsewhere.

Mr. Sampson wishes to acknowledge his obligation to Professor Call for assistance and the identification of some of the species given in the present list; also to C. C. Allen, of Florida, formerly of Eureka Springs, and to O. A. Crandall, of Sedalia, Missouri, for specimens collected by them, and to Dr. V. Sterki, of New Philadelphia, Ohio, for examining the Pupidæ.

JOHN C. BRANNER.

A PRELIMINARY LIST

OF THE

MOLLUSCA OF ARKANSAS.

(Exclusive of the Unionidæ)

BY F. A. SAMPSON, A. M.,
Sedalia, Missouri.

PULMONATA GEOPHILA.

MONOTREMATA.

HOLOGNATHA.

SELENITIDÆ.

1. *Selenites concava* Say.

Carroll, 2; Independence, 3; Cross (Call); Saline (Call).

LIMACIDÆ.

2. *Limax campestris* Binn.

Carroll; Crawford; Sebastian; Pulaski; Franklin; Perry; Nevada.

Specimens from Franklin county were of unusual size, being nearly two inches in length.

3. *Zonites friabilis* W. G. B.

Carroll, 4; Garland, 4; Helena, Phillips (Binn. Coll.); Independence, 3.

In the southwest this species takes the place of *Z. fuliginosus*. I have it also from Fort Scott, Kansas, Carthage and other places in Missouri.

4. *Zonites lævigatus* Pfeiffer.

Binney states in his Manual of North American

Shells that this species is found from Pennsylvania to Arkansas.

5. *Zonites demissus* Binn.

Pulaski, 1; Hot Spring, 1; Independence, 1; Randolph; Hot Springs, Garland (Binn. Coll.).

A single specimen only was found by me in the first three counties.

6. *Zonites brittsi* Pils.

Garland, 6; (Type lot).

A number of specimens were collected by Mr. R. A. Blair, of Sedalia, Missouri, at Gillen's Spring, four miles east of Hot Springs, which have since been described by Mr. Pilsbry in *Nautilus*, volume V., p. 99, January, 1892. They are very close to *Z. demissus*, but have closed umbilicus. Shells of all sizes have the internal thickening of the peristome, from which it would seem that as the shell enlarges this white added matter is dissolved away leaving the shell of ordinary thickness except near the aperture.

7. *Zonites ligerus* Say.

Franklin, 2; Sebastian, 1; Jackson, 6; Independence, 6; Cross, 1.

In considerable numbers at Newport, in Jackson county; scarce in other counties. At Newport they were found on low ground, and were considerably larger than in the other counties.

8. *Zonites arboreus* Say.

Carroll, 2; Benton, 20; Washington, 9; Sebastian, 4; Crawford, 1; Franklin, 15; Conway, 3; Pulaski, 1; Garland, 1; Hot Spring, 2; Hempstead, 3; Nevada, 2; Yell, 1; Cross, 2; Forrest City, St. Francis (Call).

9. *Zonites viridulus* Mke.

Carroll, 2; Benton, 4; Crawford, 7; Conway; Sebastian.

10. *Zonites indentatus* Say.

Carroll, 16; Benton, 10; Washington, 3; Crawford, 3;

Sebastian, 5; Franklin, 4; Conway, 4; Pulaski, 1; Clark, 1; Hempstead, 1; Nevada, 2; Yell, 1; Cross, 1.

11. *Zonites minusculus* Binn.

Carroll, 1; Crawford, 1; Franklin, 9; Conway, 3; Pulaski, 1; Nevada.

At Mulberry in Franklin county I found a number of specimens, and from each of the other counties only from one to three.

12. *Zonites placentula* Schutt.

Hot Spring; Garland (Binney's Manual).

13. *Zonites fulvus* Drap.

Crawford, 1; Franklin, 1; Conway, 13.

14. *Zonites———?*

Washington, 1.

Very much in size and general appearance like *arboreus*, but of six whorls.

15. *Zonites———?*

On the Boston Mountains in Crawford county I found a shell bearing considerable resemblance to *Z. limatulus* Ward, but of only 3 mm. diameter, more depressed, sutures less impressed and outer whorl more rounded.

16. *Zonites gularis* Say.

Malvern, Hot Spring, 1.

A single specimen found.

PHILOMYCIDÆ.

17. *Tebennophorus caroliniensis* Bosc.

Carroll; Crawford; Sebastian; Franklin; Pulaski; St. Francis (Call).

HELICIDÆ.

18. *Patula solitaria* Say.

Carroll, 5.

A few shells were found near Eureka Springs, of small size and much elevated. Binney notes in his Manual that he has never received it from south of Missouri.

19. *Patula alternata* Say.

Carroll, 11; Washington, 4; Crawford, 7; Sebastian, 8; Franklin, 13; Garland, 1; Nevada, 6; Conway, 7; Perry, 5; Yell, 5; Clark, 2.

From the first county the shells do not differ much from those from more northern localities, but from the others they are darker and much heavier ribbed.

The state collection has specimens from the Post-pliocene of Clark county.

20. *Patula perspectiva* Say.

Carroll, 14; Benton, 5; Crawford, 1; Cross, 2; Independence, 7.

In abundance in the first county and but few in the others.

21. *Helicodiscus lineatus* Say.

Carroll, 1.

22. *Strobila labyrinthica* Say.

Crawford, 2; Benton; Carroll; Nevada.

One of the two specimens found in the first county was under the same log with the only *Zonites fulvus* found in the same county.

23. *Polygyra texasiana* Moricand.

Sebastian; Nevada.

All of the specimens I have seen of this species are of a pale horn color, with quite prominent ribs on the upper surface, teeth on peristome not far apart and pointing towards each other, the parietal tooth distinctly connecting the extremeties of the peristome. In Sebastian county I found three shells having all these characteristics. Opposite Fort Smith in Indian Territory the species is quite plentiful.

24. *Polygyra triodontoides* Bland.

Washington, 6; Sebastian, 6.

Shells similar to the above, but thinner, sub-pelucid and of a darker color, the teeth on the peristome further apart, and the basal ones pointing rather to the base than to the other tooth. The parietal tooth is

much smaller and does not distinctly connect the margins of the peristome.

25. *Polygyra jacksoni* Bland.

Carroll, 5; Washington, 6; Crawford, 3, 6; Sebastian, 6; Franklin, 5.

At Eureka Springs in Carroll county this rare species occurs in considerable numbers among the gravel and small stones on the hill sides and rarely under large stones. The size was typical, being about 7 mm. in diameter, and varying but little.

On the bluffs of the Arkansas River at Van Buren the size is much larger varying from 8–7 to 9–8 mm. diameters. At this place they are rather plentiful under large stones and high up on the sides of the river bluffs. At the other points in this county, and in other counties named, except Sebastian, they are of ordinary size, while in the latter they are nearly as large as those from Van Buren. In Franklin county they were found under some rails on the side of the bluff but little above the river bottom.

26. *Polygyra dorfeuilliana* Lea.

Hempstead, 4; Hot Springs, Garland (Binn. Coll.), 5; Nevada, 5; Mammoth Spring, Fulton, 7.

Four shells of 7 mm. diameter were found at Hope in the first county.

27. *Polygyra dorfeuilliana* Lea.

Var. *sampsoni* Wetherby.

Carroll, 12; Benton, 5; Washington, 2; Crawford, 7, 5; Franklin, 1; Pulaski, 2; Johnson, 2; Perry, 2; Garland, 6.

In Carroll county this variety occurs in large numbers, frequently fifteen or twenty under a single stone. The specimens vary in size from 10½–8¾ mm. to 7–6¼ mm. diameters, and in Benton they are still smaller, 7–5½ mm. These were from some timber on the prairie.

On the bluffs at Van Buren where the *P. jacksoni*

are unusually large none were found, though at a lower point on the bluff not far away some larger than the average size were obtained. On the Boston Mountains in the same county they are considerably smaller.

28. *Polygyra leporina* Gld.

Crawford, 3; Sebastian, 3; Franklin, 3; Conway, 3; Pulaski, 5; Clark, 3; Perry, 3.

This species inhabits low or bottom lands and is not abundant anywhere.

At Argenta, Pulaski county, it was found under all cedar logs at the railroad yards, but none under pine. In fact it is very seldom that a shell of any kind is found under pine logs.

29. *Stenotrema labrosum* Bland.

Carroll, 5; Benton, 6; Washington, 1; Crawford, 6; Franklin; Johnson, 5; Garland; Washita Springs, Montgomery, (Binn. Coll.); Conway, 7; Perry, 4; Yell, 1; Independence, 4.

In the first county in considerable abundance at Eureka Springs; at Van Buren, Crawford county, they are the largest, they are but 8 mm. in diameter in Johnson county.

30. *Stenotrema edgarianum* Lea.

Binney's Manual of American Land Shells gives this as found in the State.

31. *Stenotrema stenotremum* Fer.

Clark, 3; Garland(Smithsonian Coll.); Independence, 4.

32. *Stenotrema monodon* Rack.

Crawford, 4; Sebastian, 2.

The variety *fraterna* was found in these two counties, and in large numbers in Indian Territory opposite Fort Smith.

33. *Stenotrema leaii* Ward.

Benton, 10; Washington, 6; Carroll; Nevada.

34. *Triodopsis obstricta* Say.

Independence, 1.

The only specimen found shows several differences from Indiana and Tennessee specimens in my collection, being smaller, 20½–18 mm. diameters, spire more flattened, superior tooth on peristome smaller, and decidedly more coarsely striated.

35. *Triodopsis appressa* Say.

Carroll, 3; Crawford, 6; Jackson, 4; Helena, Phillips (Binn. Coll.); Johnson, 2.

From the bluffs of White River, Carroll county, the shells of this species were thin and of a light horn color with no indication of tooth on the peristome even on the basal side, and with striæ very fine, so that the shells were somewhat glabrous. The largest were 21½–18 mm. and of nearly six whorls. They remind one very strongly of *M. roemeri*.

On the bluffs of the Arkansas, at Van Buren, the same variety was found, the largest observed being 19–16 mm.

From Jackson county the shells were much more elevated, of a reddish horn color, with strong rib-like striæ, and with tooth on the basal side of the peristome more pronounced than in the typical shell, and with the peristome heavier and more reflected. They were of five whorls, and 19–16½ mm. diameters.

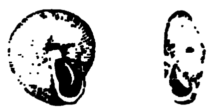
36. *Triodopsis inflecta* Say.

Carroll, 14; Benton, 8; Washington, 8; Crawford, 5; Sebastian, 7; Franklin, 9; Johnson, 1; Conway, 7, 3; Garland, 1; Hot Spring, 1; Clark, 5; Jackson, 3; Perry, 7; Yell, 7; Independence, 7; Pope, 8; Cross, 2; Fulton, 4.

In Carroll county of light color and 11–10 mm. diameters. Similar but darker ones from the other counties. In Crawford, Jackson and some other counties, some were of ordinary size, while others were 12–10 mm. diameters and much elevated.

In Franklin county they varied from 9–8 to 11–10 mm., but were mostly of the smaller size.

37. *Triodopsis edentata* Sampson.



Crawford, 3.

On the Boston Mountains I found some shells which may be described as follows:

Shell imperforate, depressed, with granulate striations, thickly covered with hair-like projections; whorls 5, the last strongly contracted at the aperture; suture not much impressed; spire short, obtuse; parietal wall with a long arcuated white tooth; umbilicus impressed, aperture contracted by a deep indentation behind the peristome; on the inner margin of the peristome are two enlargements of obsolete teeth, one near the base, the other midway between it and the right terminus of the peristome. Some specimens show no traces of these enlargements. Greater diameter, 13½, lesser, 12, height, 7 mm.

Triodopsis inflecta in Arkansas varies from 9 to 12 mm. in diameter, and the larger shells in general appearance are very much like this species with the exception of the teeth on the peristome. Had I found but one or two specimens I would have taken them to be immature *inflecta* of large size, but I got a dozen living and dead shells during the latter part of February, and they were all destitute of peristome teeth, and are as much entitled to specific distinction as *T. rugeli*, Schutt. in which the difference from *inflecta* is the distance of the upper tooth of the peristome within the aperature.

In this species the enlargements of the peristome correspond in position with the teeth of *inflecta*, but it is hardly proper to call them teeth, the thinner shells being as clear of teeth as a typical *Mesodon*, and only the old thickened shells have the obsolete teeth. They attain a size somewhat larger than the largest specimens of *inflecta* in the Binney collection.

Professor R. E. Call believes them to be T. *appressa minor*, but they seem to be nearer *inflecta* than *ap-*

pressa, and if not a good species, they are certainly a well marked variety. The discription of this species was published in *Nautilus* in December, 1889.

38. *Triodopsis fallax* Say.

Carroll, 5, 2; Benton, 1.

A small variety 10 to 11 mm. diameter was found in considerable numbers at Eureka Springs, a part of them albinos. In Benton county only a single shell was obtained.

39. *Triodopsis vultuosa* Gld.

Benton, 3; Washington, 2; Crawford, 1; Sebastian, 1; Nevada (Crandall).

Binney gives this species as occuring in Arkansas and Texas, but I have found it as far north as Benton county and Sedalia, Missouri.

There seems to be very little variation in it in the different counties named, from each of which from one to three specimens were obtained.

In December, 1888, a number were found at Rogers, in the first county, and all of them occurred in pairs under logs.

40. *Mesodon albolabris* Say.

Carroll, 7, 4, 3; Benton, 4; Sebastian, 1; Crawford, 1; Garland, 2; Washington; White (Call); Johnson, 1; Nevada, 5; Independence, 1.

At Eureka Springs the country is mountainous, and the valleys very narrow, having on the sides ledges of rocks making almost continuous walls, and gradually ascending from the beds of the streams high up the hill sides. Along these ledges many shells may be found, and in the spring and summer the different species of *Mesodon* adhere to the rocks on the under side of the edges.

This species is of much lighter color and more transparent than the specimens found in the states further east. I have shells from Indiana about 29 mm.; from Sedalia, Missouri, 25 to 31 mm; from Eureka

Springs up to 34 mm. Of them Prof. Wetherby says:

"Specimens of the average size have the spire very much depressed, the aperture correspondingly elongated transversely and the surface very highly polished. The reflection of the peristome is much narrower, by its being somewhat folded. It is a very distinct variety, which I have not before seen."

There is also a smaller variety darker colored, thicker, and more elevated, which has been named variety *alleni* by Wetherby, in honor of Mr. C. C. Allen, formerly of Eureka Springs. The two varieties were found together, and along with them variety *minor*, being still smaller than *alleni*, and more like the large specimens.

The single shell found in Sebastian county and the two in Garland county were of the larger variety, while two from Rogers, in Benton county, were small, 22–19 mm. and 21–17 mm. diameter. Those from Nevada county were also small.

41. *Mesodon divestus* Gld.

Carroll, 5; Benton, 5; Crawford, 2; Franklin, 2; Garland, 2; Sebastian; Conway, 1; Yell, 6.

This rare shell was found in considerable numbers at Eureka Springs, along with *albolabris*, *thyroides* and *exoletus*. The size was typical, 18–15 mm.

Those from Benton county were only 14–12 to 15–13 mm. Very few were found, except in the first county, and these were larger than from any other county.

42. *Mesodon elevatus* Say.

Carroll, 3; Benton, 1; Crawford, 2; Clark, 1; Jackson, 2; Augusta, Woodruff (Call).

Differing but little from more northern localities. Found on low ground or adjacent thereto.

43. *Mesodon exoletus* Binn.

Carroll, 2, 6; Benton, 1; Washington, 1.

The specimens vary greatly in size, those from near

the White River in Carroll county being 25 mm. in diameters.

Those from Eureka Springs in the same county were much smaller, as low as 21 mm. diameters, and concerning which Mr. Binney writes, "I think them very curious."

From Rogers, in Benton county, and from Washington county they are still smaller, being only 18½ mm. diameters, and are not easily distinguished from the small *thyroides bucculentus* with closed umbilicus. For some time after the lip is formed the shell is thin, and has no parietal tooth, but it afterwards thickens and a rather heavy tooth is formed.

One interesting pathological specimen shows that a part of the shell had been broken away, and afterwards a new peristome formed, with a new parietal tooth about two mm. back of the first one.

44. *Mesodon thyroides* Say.

Carroll; Benton, 4; Crawford, 3; Sebastian, 2; Franklin, 4; Conway, 1; Pulaski, 3; Jackson, 3; Nevada, 1, 4; St. Francis (Call); Perry, 1; Yell; Johnson, 1; Independence, 2; Cross, 2.

This species was originally described as of 22–19 mm. diameters, but I have it from Indiana 28–23 mm., and from Ohio and Missouri nearly as large.

From Carroll county the shells were 22–19½ mm., and were found along with *albolabris*, *exoletus* and *divestus*, near to and on the underside of the ledges before mentioned. These specimens have been identified by various persons as *bucculentus*, but some from Benton county seem more properly of that variety. They were 18–15 mm., and from Rogers, in that county, one was 16–13½–9 mm. One had a parietal tooth, but the others did not show any and could be distinguished from *clausus* only by their less height.

A few days before the death of Mr. Tryon, I asked him to show me the difference between such speci-

mens and *clausus*, from the specimens in the collection of the Philadelphia Academy. Sending Mr. Pilsbry with me, the latter found some *clausus* fastened on cards with *bucculentus*, and some *bucculentus* on cards with *clausus*, showing how close the resemblance was.

Two shells from Sebastian county, though apparently mature, had no parietal tooth. The shells from Argenta were gathered in December, and the most of them had no lips formed, while those that did, had no parietal tooth. The mature ones were of much lighter color than the younger ones.

The largest found was from Newport, being 24–20 mm. At Mulberry, in Franklin county, they vary in size and color, three being about 20-17 mm., one of them much redder than the others. Three from the same place are 19½–14½ mm. and with covered umbilicus, while two others are 16½–14 mm.

Professor Call found them abundant in St. Francis county, along Little Crow Creek near Forrest City.

45. *Mesodon clausus* Say.

Carroll, 5; Clark, 2; St. Francis (Call); Yell, 1; Washington.

46. *Mesodon kiowænsis* Simpson.

Var. arkansensis Pils.

Garland, 5 (Type lots).

47. *Dorcasia berlandieriana* Moricand.

Binney's Manual gives this species as occurring in Arkansas and Texas. It probably occurs in the southwestern part of this State.

BULIMULIDÆ.

48. *Bulimulus dealbatus* Say.

Carroll, 6; Crawford, 3, 5; Franklin, 1; Garland (Smithsonian Coll.); Benton, 4.

I have this not only from northern Arkansas, but from as far north as Cooper county, in central Missouri.

PUPIDÆ.

49. *Pupa fallax* Say.

Carroll, 20; Franklin, 30; Pulaski, 14.

50. *Pupa armifera* Say.

Carroll, 20; Washington, 15; Sebastian, 1; Franklin, 15; Crawford, 2; Conway, 13; Helena, Phillips (Call).

51. *Pupa contracta* Say.

Benton, 3; Sebastian, 2; Carroll; Helena, Phillips (Call).

52. *Pupa procera* Gld.

Carroll, 1.

ELASMOGNATHA.

SUCCINIDÆ.

53. *Succinea ovalis* Gld.

Carroll, 3.

54. *Succinea avara* Say.

Carroll, 1; Franklin, 7; Conway, 1; Jackson, 5; Perry, 2; Hempstead, 1.

55. *Succinea obliqua* Say.

In the Binney collection are specimens from the state, but the county is not given.

HELICINIDÆ.

56. *Helicina orbiculata* Say.

Carroll, 11; Benton, 1; Hot Springs, Garland (Smithsonian collection).

PULMONATA LIMNOPHILA.

LIMNÆIDÆ.

Sub-Family LIMNÆINÆ.

57. *Limnæa humilis* Say.

Leatherwood Creek, Carroll, 20; White River, Jackson, 1; Mammoth Spring, Fulton, 1.

A single dead shell was found at Eureka Springs in a small stream which contained plenty of *Pisidium* and *Ancylus*, and no living shell was found until ten years

later, when they were found in abundance a mile or two below the town.

58. *Limnæa columella* Say.

Illinois Creek, Washington, 4; Vache Grasse Creek, Sebastian, 6; Big Creek, Sebastian, 4; Ouachita River, Hot Spring, 7; Johnson, 9.

59. *Physa gyrina* Say.

Carroll; Washington; Hot Spring; Clark; Crawford; Franklin; Benton. (30 lots averaging about 10 shells each).

As usual with the species of this genus the size and shape vary much, and in some cases it is rather difficult to place the specimens in either of the two recognized common species.

In a small pool in the bed of a stream which latter had apparently been dry for a long time, near Mulberry, Franklin county, the shells were quite abundant, the leaves in the water being almost covered with them. The water seemed to be from a spring; a few rods above was a large hole with water but no shells in it. Those found were thickly coated with black, and when cleaned were of a decidedly reddish tinge, the lips much thickened on the inside and of a red color, the corresponding line on the outside being yellowish; shell firm and thick; spire gradually acuminating to a sharp point; suture considerably indented; whorls 6; length 11 mm.; length of opening 7½ mm. The same variety was found in several counties.

Some specimens gathered by me in West Leatherwood Creek at Eureka Springs in Carroll county have been named *Physa albofilata* by Mr. C. F. Ancey, of Marseilles, France, but I do not know whether the description has yet been published. They differ from the typical *gyrina* in having the body whorl large as in *heterostropha* but with the opening smaller, seldom reaching two-thirds of the length, whorls few, about 4 or 5, the first being eroded at two localities in West

Leatherwood Creek, but not in a small stream emptying into it close by. The white lines showing rests of growth are distinct and numerous in some and in others wanting.

The largest and finest shells were gathered in June and July, 1881, when they were very plentiful. In March, 1886, they were found in the smaller stream only, and were of small size and few in numbers. In November, 1886, and November, 1887, none were found at any of these localities. In December, 1888, the shells were rather plentiful, and in July, 1890, and in July, 1891, they were abundant in the side stream, of large size, and not eroded.

West of White River in the same county the shells did not have so large a body whorl, and were of six whorls. From the head waters of Sugar Creek in Benton county, the same shell was found; aperture two-thirds of the length, six whorls, many white lines and the same general appearance as the Eureka Springs shells.

Some of the Eureka Springs shells measured were 9½–7, 16–11, 17½–12 and 20–13 mm. diameters.

Other varieties of *gyrina* and *heterostropha* were found, but no attempt will be made in this report to identify them with names that have been published.

60. *Physa heterostropha* Say.

Sebastian; Washington; Pond at Dardanelle, Yell. (Six lots averaging six shells each).

The same variation is found in this as in the preceeding. From a pond in Washington county the variation was from the bulky shape of this species, to that of *gyrina*.

Sub-Family PLANORBINÆ.

61. *Planorbis trivolvis* Say.

Benton, 7; Carroll; Pond at Fayetteville, Washington, 7; Vache Grasse Creek, Sebastian, 7; Little

Vache Grasse Creek, Sebastian, 4; Big Creek, Sebastian, 10; Lake, Newport, Jackson, 1; Pond at Knobel, 3; Mammoth Spring, Fulton, 4.

62. *Planorbis vicarinatus.*

White River, Carroll, 8; Big Creek, Sebastian, 1; Ouachita River, Hot Spring, 3.

Sub-Family ANCYLINÆ.

63. *Ancylus tardus* Say.

Carroll; Washington; Big Creek, Sebastian; Benton.

In 1881 the several streams about Eureka Springs had great numbers of this species. In one the shells were quite large and scarce; in June, but a month later none were found of more than half the size, but they were in great numbers. There is considerable variation in the specimens and none of them correspond exactly with the description of this or any of the other species.

OPERCULATED SHELLS.

VIVIPARIDÆ.

64. *Vivipara contectoides* W. G. Binney.

Lake at Newport, Jackson, 6.

65. *Vivipara subpurpurea* Say.

White River, Jackson, 6.

66. *Campeloma subsolidum* Anthony.

White River, Carroll; Ouachita River, Hot Spring; Ouachita River at Arkadelphia, Clark (Call)

Professor R. E. Call in the bulletin of the Washburn College Laboratory for May, 1886, Volume I, No. 5, page 155, gives the habitat of this species as far south as central Arkansas.

67. *Campeloma ponderosum* Say.

White River, Jackson, 1.

Fine specimens were sent me by Mr. Allen from the White River at Newport.

RISSOIDÆ.

68. *Pomatiopsis lapidaria* Say.

Carroll, 5; Jackson, 5.

STREPOMATIDÆ.

69. *Pleurocera subulare* Lea.

White River, Carroll; White River, Jackson (Allen); King's River, Carroll; Ouachita River, Hot Spring; Ouachita River, Clark (Call).

In the White River in Carroll county none but small, but apparently mature specimens were found, though in King's River at the same time large as well as small ones werė found, and the latter seem identical with the White River specimens.

70. *Pleurocera canaliculata* Say.

Ouachita River, Hot Spring; Ouachita River, Clark (Call).

71. *Goniobasis lawrenci* Lea.

Ouachita River at Arkadelphia, Clark (Call).

This was described from specimens from Ouachita River, Hot Spring county, and is quoted by Call in the Washburn College Bulletin as one of the species found west of the Mississippi River; he found it abundant in 1888 as above.

72. *Goniobasis plebeius* Anthony.

Ouachita River at Arkadelphia, Clark (Call).

Described from specimens from Saline county. Tryon believed this to be a synonym of *G. saffordi* Lea, but in his former published work he gave it as a synonym of *G. sordida* Lea. The species is quoted by Call in the Bulletin above mentioned.

73. *Goniobasis cubicoides* Anthony.

Illinois Creek, Washington, 9; White River and King's River, Carroll, 20, 12; Mulberry Creek, Franklin, 15; Branch Sugar Creek, Benton, 9; Ouachita River, Hot Spring, 3.

Specimens of this species were submitted to Tryon

and pronounced by him *G. saffordi* Lea, and that both *cubicoides* and *plebeius* were synonyms of this. They are all of darker color than those of Southern Missouri, and from many localities they are banded. In the White River in Carroll county like the *Pleurocera*, they were quite small, some being uniformly light colored, some dark colored, some of two bands, and some of many bands.

74. *Goniobasis crandelli* Pils.

Mammoth Spring, Fulton 5 (original lot).

The type specimens of this species were collected by Mr. O. A. Crandall in the stream near Mammoth Spring, where it is found in great numbers. The description was published in the Proceedings of the Academy of Natural Sciences of Philadelphia, 1890, page 301, plate V., figures 4 and 5.

CORBICULADÆ.

75. *Sphærium sulcatum* Lam.

White River, Carroll, 8.

76. *Sphærium striatinum* Lam.

Vache Grasse Creek, Sebastian, 10; Benton, 5.

77. *Sphærium stamineum* Conr.

Prime in the work mentioned below states that this species is found in Arkansas.

78. *Sphærium partumeium* Say.

Pond, Sebastian; Washington.

Prime in "America Corbiculadæ" states that this species is found in Arkansas, and that the *Sphærium eburnea* described by Anthony from Arkansas specimens is a synonym, varying from the northern *partumeium* in being more compressed and a little more elevated.

79. *Sphærium transversum* Say.

Prime states that this species occurs in the State, and it will doubtless be found in abundance in many localities.

80. *Pisidium abditum* Hall.

Carroll, 60.

Found in great numbers in one of the small streams at Eureka Springs.

81. *Pisidium virginicum* Bourg.

White River, Carroll, 10.

A PRELIMINARY LIST

OF THE

MYRIAPODA OF ARKANSAS.

BY CHARLES H. BOLLMAN.

INTRODUCTION.

The following list of the Myriapoda of Arkansas is chiefly the result of Mr. Bollman's own work. Most of his collecting was done in the summer of 1887, and through the dry pine regions of the southwestern part of the State—conditions very unfavorable for collecting myriapods.

The list, with descriptions of new species, was originally published in the *Entomologica Americana* in 1888. It was then hoped that Mr. Bollman might continue his studies of the insects of the State, but most unfortunately he did not live to complete his well-begun work.

Of a necessity the list is incomplete, for whatever work of this kind is done by the members of the Geological Survey must be done incidentally in connection with the principal objects of the Survey's work. It is hoped, however, that its publication will tend to foster an interest in the natural history of a state whose natural history is so interesting and yet so little known.

JOHN C. BRANNER,
State Geologist.

A PRELIMINARY LIST

OF THE

MYRIAPODA OF ARKANSAS.

With Descriptions of New Species.

BY CHARLES H. BOLLMAN.

1. *Platydesmus lecontei* (Wood).

   One was found on the grounds of the Deaf Mute Asylum and others on the hills along the south side of the river, near Little Rock.

2. *Julus minutus* (Brandt).

   I found one specimen in the swamp at the south end of Main Street, Little Rock. Mr. W. J. Hutcherson, one of the assistants of the Geological Survey, also found one near Argenta.

3. *Spirobolus marginatus* (Say).

   Abundant throughout the state.

4. *Parajulus cæsius* Bollman.

   Julus cæsius Wood, Proc. Phila. Acad. Nat. Sci., 43, 1867 (Texas).

   This species is not uncommon throughout the state.

5. *Cambala annulata* (Say).

   Numerous specimens of this species were collected in the vicinity of Little Rock by Mr. W. J. Hutcherson.

6. *Lysiopetalum lactarium* (Say).

   Common throughout the state.

7. *Campodes flavicornis* Koch.

   Campodes flavicornis Koch, Syst. der Myr., 126, 1847 (Pa.).

Campodes fusicornis Koch, Syst. der Myr., 127, 1847 (Pa.).

Spirostrephon cæsioannulatus Wood, Trans. Amer. Philos. Soc., 194, 1865 (Alleghany Co., Pa.); Ryder, Proc. U. S. Nat. Mus., 526, 1880.

Pseudotremia vudii Cope, Proc. Amer. Philos. Soc., 180, 1869 (Montgomery Co., Va.); Ryder, Proc. U. S. Nat. Mus., 527, 1880.

Cryptotrichus cæsioannulatus Packard, Proc. Amer. Philos. Soc., 190, 1883 (Culmana, Ala., or Ocean Springs, Miss.).

A single specimen was obtained at Little Rock. As this species has a number of synonyms, I have given its synonomy.

8. *Craspedosoma flavidum* sp. nov.

Yellowish brown, feet and antennæ lighter. Robust, segments not constricted, lateral carinæ small and body strongly resembling that of *Campodes*. Antennæ longer than width of body. Ocelli 12–14, distinct, arranged in a triangular patch and in five or six series. Dorsal plates rather smooth, setigerous granules small, setæ rather large. Male feet crassate, those of female slender.

Length of body 5.8 mm.; width .7 mm.

Hab.—Okolono.

This species strongly resembles a *Campodes*. In life the individuals are a dusky yellow. This description is based upon a male and female.

9. *Craspedosoma carniatum* Bollman.

Not common in the Fourche bottoms, south of Little Rock; found on the grounds of the Deaf Mute Asylum.

10. *Leptodesmus hispidipes* (Wood).

Abundant everywhere.

Very common throughout the state. All specimens obtained were young, but the shells of many adults were found.

11. *Euryurus evides* Bollman.

Paradesmus evides Bollman, Ent. Amer., II, 229, 1887 (Winona, Minn.).

Common over the state. Specimens agree with those from Minnesota.

12. *Chætaspis albus* Bollman.

Chæstaspis albus Bollman, Ent. Amer., III, 46, 1887 (Bloomington, Ind.).

One specimen obtained at Little Rock.

13. *Polydesmus minor* sp. nov.

Dark shining brown, lighter beneath. Moderately slender, depressed, slightly acuminate anteriorly and posteriorly, smooth, very sparsely pilose (setigerous). Antennæ equal to width of body, subclavate. First plate wide, angles not or but slightly produced; not toothed, tubercles not distinct, except lateral. Other dorsal plates with posterior angles produced, especially posteriorly; lateral margins three or four toothed, indistinct posteriorly, tubercles distinct, arranged in two rows of four each, anterior border indistinctly divided into two, posteriorly, the last row of tubercles project beyond border of segments. Legs long, crassate in male.

Male: copulation foot very similar to *serratus;* ventral plates produced into a short, pilose lobe anteriorly.

Length of body 10—14 mm., width 1.5—1.8 mm.

Hab.—Little Rock.

This species is described from a number of specimens found in the low lands along Fourche Bayou south of Little Rock.

14. *Polydesmus pinetorum* sp. nov.

Very similar to *P. serratus*, but the general color paler and size smaller. Tuberculation not so distinct, sides of first segment one toothed, other distinctly three or four toothed. Last row of scales on posterior segments composed of six or eight setæ tipped scales, which project beyond border of segments. Ventral

plate of ninth pair of legs not produced as in *serratus*, copulation foot very similar.

Length of body 15 to 18.5 mm.; width 2.2 to 2.8 mm.

Hab.—Little Rock, Arkadelphia, Okolona, Murfreesboro and Ultima Thule.

As already indicated, this species is closely related to *serratus*. It is principally separated by its smaller size and form of the ventral of ninth pair of legs of male.

This species may only represent a geographical form of *serratus*. It is very abundant throughout the state, and all those collected during the summer were in the larva stages. Mr. W. J. Hutcherson obtained adult specimens.

15. *Fontaria virginiensis* (Drury).

Abundant at Donaldson, common at Okolona.

Specimens from Arkansas are similar to those from North Carolina, but those from northern parts of Mississippi valley represent geographical species.

At Donaldson the adults were found crawling on the surface of the ground in company with a large number of their young, probably one adult to five or eight hundred young, then (July 11, 1887,) about half grown.

This species seems to be more abundant in river bottoms and in low rich woodlands.

The odor of prussic acid is strongly emitted by this species through a series of pores on each side of the body.

16. *Sphæriodesmus pudicus* sp. nov.

General color pinkish, especially posteriorly, anterior half of segments darkest, a black median dorsal line, antennæ dark, legs pale. Body widest and highest anteriorly, tapering posteriorly, smooth, setæ absent. Vertex smooth, somewhat sulcate. Antennæ subclavate, about equalling width of body. Dorsal plates smooth, four preceding the last with an indis-

tinct row of obtuse scales; lateral plates except the first, antepenult and penult with their posterior margin serrate. Anal plate triangular with the angles rounded, sparsely pilose. Legs long and slender, extending beyond sides of body.

Male: ventral plate of second pair of legs produced into two short cones; coxæ of second and third pairs more pilose than others; copulation foot much twisted, end expanded and divided, pilose.

Length of body, 7 mm.; width, 2 mm.

Hab.—Little Rock and Okolona.

This is the first time that any species of this genus has been found in the United States. It is easily distinguished from *S. mexicanus* (Saussure), by having a few scales on posterior dorsal plates.

The collection contains two specimens of this species.

17. *Polyxenus fasciculatus* Say.

Common at Little Rock, five were obtained at Antoine and one at Ultima Thule.

18. *Pauropus lubbockii* Packard.

A few specimens were obtained at Little Rock.

19. *Linotænia bothriopa* (Wood).

One specimen was collected near Little Rock by Mr. Hutcherson.

20. *Linotænia robusta* (Meinert).

Scolioplanes robustus Meinert, Proc. Amer. Phil. Soc., 224, 1886 (? N. A.).

Frontal plate present. Fulvous, head and antennæ dark. Not robust; attenuated anteriorly and posteriorly; moderately smooth, sparsely pilose. Prehensorial feet smooth, sparsely pilose; sternum subcordiform, length and width subequal; coxæ a little wider than long, unarmed; tooth strong, acute; claw small, a little curved. Cephalic plate somewhat wider than long, smooth, sparsely pilose, sides strongly rounded, slightly diverging, posterior margin only covering a small part of basal plate, basal plate

densely pilose. Anal legs produced, armed, rather densely pilose beneath, crassate. Pairs of legs of male 61; of female 63.

Length of body 40 mm.

Hab.—Okolona.

There are two adults of this species in the collection. It is separated from other North American species by having no coxal pores and the prebasal plate exposed.

24. *Geophilus salemensis* Bollman.

One specimen was collected near Little Rock by Mr. W. J. Hutcherson.

25. *Cryptops hyalinus* Say.

Cryptops hyalina Say, Journ. Phila. Acad. Nat. Sci., III, 1820 (E. Florida); Say, Oeuvres Ent., sp. 3, 1822; Newport, Trans. Linn. Soc., 409, 1844; Newport, Cat. Myr. Brit. Mus. Chil., 60, 1856; Wood, Trans. Amer. Philos Soc., 168, 1865; Underwood, Ent. Amer., 65, 1887.

Cryptops hyalinus Koch, Syst. d. Myr. 175, 1847; Gervais, Aptères, IV, 293, 1874.

? *Cryptops milberti* Gervais, Aptères, IV, 592, 1847 (New Jersey).

? *Cryptops milbertii* Wood, Trans. Amer. Philos. Soc., 168, 1865; Underwood, Ent. Amer. 65, 1887.

Cryptops asperipes Wood, Proc. Phila. Acad. Nat. Sci., 129, 1867 (Montgomery Co., Virginia), McNeill, Proc. U. S. Nat. Museum. 326, 1887 (Pensacola, Fla.); Underwood, Ent. Amer. 65, 1887.

Cryptops sulcatus Meinert, Proc. Amer. Philos. Soc., 211, 1886 (Bee Spring, Ky.); Underwood, Ent. Amer., 65, 1887.

The study of a large series of specimens of the genus *Cryptops* has convinced me that all the species of *Cryptops* described from North America belong to a single species—*hyalinus* Say.

I have questioned the *Cryptops milberti* of Gervais,

because the author states that the spines of the last pair of feet are absent. This character is contrary to the true definition of *Cryptops* and I am inclined to think that either Gervais had an abnormal specimen or that his observations were incorrect.

Asperipes Wood, has been separated from the other species by the number of antennal joints (19), which he assigned to his species, but as the number of joints has recently been found to be variable it is not a true character upon which species can be based.

In Entomologica Americana, 65, 1887, Dr. Underwood says the last pair of legs of *sulcatus* Meinert, are unarmed, as in *milberti* Gervais, but in this he is mistaken, for, in his generic description Dr. Meinert states that the last pair of legs are armed with a definite number of spines.

Considering this state of characters, I believe that all the described species should be united under *C. hyalinus*. I have examined specimens of this species from the following States: Maryland, Pennsylvania, Indiana, Tennessee, North Carolina, Florida, Indian Territory, and Arkansas, where it is very common.

26. *Theatops spinicaudus* (Wood).

Abundant from Little Rock to Ultima Thule.

27. *Scolopendra heros* Girard.

Two adults were obtained at Little Rock, several young at Murfreesboro and Muddy Fork.

28. *Scolopendra woodii* Meinert.

A single specimen was taken at Donaldson.

29. *Scolopocryptops sexspinosus* (Say).

Common at all points; these specimens are of a darker shade than northern or eastern examples.

30. *Henicops fulvicornis* (Meinert).

A single specimen was obtained at Little Rock near the Deaf Mute Asylum. This is a European species, and the only other recorded North American locality where it is found is Mount Lebanon, New York.

31. *Lithobius branneri* Bollman.

A single specimen was obtained at Okolona, and another at Litte Rock.

32. *Lithobius providens* Bollman.

A few were obtained at Little Rock. One individual is considerably larger than any specimen collected before.

33. *Lithobius pinguis* sp. nov.

Posterior angles of all the dorsal plates straight. Anal pair of legs armed with two claws. Coxal pores few, in a single series. Penultimate pair of legs armed with two claws. Coxæ of the posterior feet unarmed. Dark chestnut brown, head and antennæ dark, legs paler. Slender, not smooth, sparsely pilose; head wider than long (3.5:3), polished, not pilose. Antennæ short, 22- to 24-jointed, articles short. Ocelli 4 to 6, arranged in 2 or 3 series. Prosternal teeth 2+2. Coxal pores 3,3,3,2 to 4,4,4,4, round. Spines of the first pair of legs, 0,0,1; penultimate pair, 1,3,2,1 to 1,3,3,1; anal pair, 1,3,2,0. Posterior legs short.

Female: claw of the genitalia entire, stout and much curved; spines strong, subequal.

Length of body 9—10 mm.

Hab.—Little Rock.

This description is based on three specimens. This is the smallest North American species with the claw of the female genitalia entire.

34. *Lithobius celer* sp. nov.

Posterior angles of the 9, 11, 13 dorsal plates produced. Anal pair of legs armed with one claw. Coxal pores few, in a single series. Penultimate pair of legs armed with two claws. Coxæ of the 13, 14, 15 pairs of feet laterally armed. Brown of various shades, head and legs more or less chestnut, antennæ dark. Moderately robust, smooth, sparsely pilose; head about as long as wide, pilose. Antennæ rather

long, 30- to 34-jointed, articles small. Ocelli 18 to 40, arranged in 4 to 7 series. Prosternal teeth 5+5 to 7+7. Coxal pores 2,3,3,2 to 5,6,6,5, round. Spines of the first pair of legs, 1,2,1 to 2,2,1; prenultimate pair, 1,3,3,1, to 1,3,3,2; anal pair, 1,3,3,1 to 1,3,3,2. Posterior legs short.

Male: tibia of anal legs somewhat crassate, and furrowed beneath; but more furrowed in the female.

Female: claw of the genitalia, short, tripartite, middle lobe much longer, others subequal; spines moderately slender, inner shortest.

Length of body 15—25 mm.

Abundant or common throughout the state.

This species is not strongly related to any known North American locality, it should be placed near *forficatus*, which it seems to replace in Arkansas.

Dr. Wood has reported *forficatus* from Arkansas and he may have had the species which I have described.

35. *Lithobius œdipes*, sp. nov.

Posterior angles of the 9, 11, 13 dorsal plates produced. Anal pair of legs armed with two claws. Coxal pores few, in a single series. Penultimate pair of legs armed with two claws. Posterior coxæ unarmed. Brown, head and antennæ dark, legs and ventral plates paler. Robust, not smooth, sparsely pilose; head smooth, of about equal length and breadth (3.2, 3.6). Antennæ short, attenuate, 24- to 26-jointed (male, 26, female, 24). Ocelli, 9 to 11, arranged in 3 or 4 series. Prosternal teeth, 2+2, or 3+3. Coxal pores 3,5,4,3 to 6,5,5,5 round. Spines of the first pair of legs 1,1,1; penultimate pair 1,3,3,2; anal pair 1,3,3,1. Posterior pair of legs short.

Male: femur of the last pair of legs somewhat bent inwardly and swollen; tibia very strongly swollen, especially above and having a bunch of hairs on

the posterior third; first tarsal joint crassate. Penultimate pair of legs somewhat swollen, principally the tibia; first tarsal joint produced into a short lobe on the inner side.

Female: posterior pair of legs scarcely swollen; claw of the genitalia entire; spines 2—2.

Length of male 15.4 mm.; of female 20 mm.

Hab.—Little Rock.

Three specimens of this species were examined. This is the only known species with both the anal and penultimate pairs of feet swollen or produced into lobes.

36. *Lithobius transmarinus* Koch.

Abundant at Little Rock, common at other localities.

37. *Lithobius mordax* Koch.

Common from Little Rock to Ultima Thule.

37. *Lithobius vorax* Meinert,

Found at all points where collections were made, but was more common at Little Rock.

39. *Lithobius multidentatus* Newport.

In a vial of Myriapods that were collected near Little Rock by Mr. W. J. Hutcherson, there is a single specimen of this species.

40. *Scutigera forceps* (Rafinesque).

One adult was seen at Arkadelphia, and several young at Little Rock.

A CATALOGUE

OF THE

FISHES OF ARKANSAS.

BY SETH EUGENE MEEK, PH. D.,
Adjunct Professor of Biology and Geology in the Arkansas
Industrial University.

INTRODUCTION.

The streams of the State of Arkansas have been too little explored to enable one to prepare an exhaustive account of its fishes. Very few collections of fishes have been made in the state and these have all been from the upland streams. Some collecting has been done, however, at points along the St. Louis, Iron Mountain and Southern Railway on the border of the lowland region, but this work has not been enough to do more than to suggest the character of the lowland fishes.

The streams of the neighboring states have also been but little explored. Some work has been done in Mississippi and Missouri; scarcely any in Louisiana and Indian Territory; but in all these states less has been done than in Arkansas. Arkansas is still a rich field for the collector and investigator, for its streams are far from having been thoroughly explored.

The present paper, however, does not pretend to be more than a simple systematic list of all the fishes known to inhabit the waters of the state, with a few supplementary notes. Under each species is given a description of that species and then is added a list of all localities in the state where the species has been collected.

THE STREAMS OF THE STATE.

The surface of Arkansas may be divided into uplands and lowlands. The uplands comprise the northwestern two fifths of the state and belong to the Ozark Mountain system. The surface of this region is much broken and fairly well timbered. Its greatest elevation is a little less than 3000 feet above sea level, while the average elevation is less than one third of that amount. Geologically it belongs to the Upper and Lower Carboniferous and to the Lower Silurian.

The rest of the surface of the state is either low and gently

rolling lands or low flat lands, the former is mostly Cretaceous and Tertiary, the latter Pleistocence and Recent. A portion of the flat region is prairie, the rest is heavily timbered.

All of the state belongs to the Mississippi basin and may be divided iuto six smaller basins, namely: the St. Francis, the White, the Arkansas, the Bayou Bartholomew, the Ouachita, and the Red River basins. The St. Francis River rises in southeastern Missouri and drains only about 5500 square miles of the northeastern portion of Arkansas. It is a broad, deep and slow flowing stream. The area, with the exception of Crowley's Ridge, is swampy. In Arkansas the St. Francis receives no important tributaries.

The White River rises in the northwestern corner of Arkansas, and after flowing northeast into southern Missouri it turns southeast and empties into the Mississippi near the mouth of the Arkansas River. The tributaries of its upper two thirds are all within the Ozark Mountain region and are mountain streams. They are fed by numerous large springs, and, except in the rainy season, their waters are very clear.

The beds of these streams are very rocky and shingly, and their currents rapid except where the streams widen into large, deep pools. These pools are quite numerous and some of them are almost large enough to merit the name of lakes. The comparatively large volume of water contained in these pools afford an excellent asylum for the larger fishes in the times of dry weather, and enables the streams to support larger fishes than they otherwise could.

White River is one of the clearest and most beautiful streams in the Mississippi Valley. It is navigable for small steamers as far as Buffalo City, a distance of more then 200 miles from its mouth. It drains an area of 17,470 square miles.

The most important tributaries of White River are, on the south, War Eagle, King's, Buffalo, and the Little Red Rivers; on the north (in Arkansas), the North Fork of the White River, and Black River; Spring and Strawberry Rivers, tributaries of Black River, are also important streams.

The Arkansas River divides the state into two nearly equal parts. The basin in the western part is half the width of the state; it narrows toward the east until near its mouth it is hardly ten miles wide. It, like the Red River, brings down from its head waters much fine silt so that its waters are always turbid. Its tributaries in Arkansas are all small and similar to the tributaries of White River. It drains in Arkansas an area of 12,300 square miles.

The Bayou Bartholomew basin drains a small portion of the state south of the mouth of the Arkansas; this region is low and flat and has never been explored for its fishes. Its drainage area is about 2650 square miles.

The Ouachita River drains most of the mountain region south of the Arkansas. Its upper tributaries rise in the mountains and resemble very much the streams of the upper White River basin. Its fauna is similar to that of of the upper Tennessee River. Its drainage area is about 11,200 square miles.

The Red River crosses the southwestern part of Arkansas and drains only a small area, 3780 square miles. Its water is nearly always turbid.

Most of the collections of fishes made in Arkansas are from the basins of the White and Ouachita Rivers. A few have been made from the Arkansas River and one from the Red, but thus far there has been no collecting from either the St. Francis or the Bayou Bartholomew basins. Arkansas is as yet but thinly settled and a thorough exploration of her streams, before their faunas have become much changed by civilization, would be of great economic and scientific interest. The increase and protection of our valuable food-fishes depends upon other things than waging war on those who use unlawful methods for their capture. The successful planting of fishes in our streams demands a thorough knowledge of their physical characteristics and of the life found in them. Such knowledge is also necessary for the protection and increase of the food-fishes native to the streams of the state. Arkansas is favored with an abundant rainfall; she is also well supplied with large and beautiful streams, and should take pride in hav-

ing her waters well stocked with such food-fishes as are adapted to them.

BIBLIOGRAPHY AND EXPLORATIONS.

Dr. Charles Girard.—During the explorations for a railroad route from the Mississippi River to the Pacific Ocean a few fishes were collected in Arkansas. These were studied by Dr. Charles Girard, and the results were published in the Proceedings of the Academy of Natural Sciences of Philadelphia, 1856 to 1859, also in Vol. VI of the Pacific Railroad Survey Report, 1858. The volume is referred to in this list as **A.**

Drs. Jordan and Gilbert.—In September, 1884, Dr. D. S. Jordan and Dr. C. H. Gilbert, under the auspices of the United States National Museum and United States Fish Commission, made collections of fishes in Arkansas at the following localities: Eureka Springs, Fort Smith, Arkadelphia, Benton and Fulton. An account of the fishes collected by them was published in the Proceedings of the United States National Museum in 1886. That paper is referred to in the present list as **C.**

Dr. C. H. Gilbert.—In the latter part of June, 1888, Dr. C. H. Gilbert made a small collection of fishes near Waldron in Scott county, and published a list of them in the Proceedings of the United States National Museum in 1888. This collection was made while Dr. Gilbert was in the employ of the Geological Survey of Arkansas. This paper is referred to here as **E.**

Dr. Seth E. Meek.—In the latter part of June, 1888, the writer, while in the employ of the Geological Survey of Arkansas made a small collection of fishes in Spadra Creek near Clarksville.

In July and August, 1888, the writer, assisted by Mr. Louis Rettger and Mr. Frank M. Drew, spent about six weeks exploring streams in the Ozark Mountain region of Missouri and Arkansas, under direction of the United States Fish Commission. The results were published in the Bulletin of United States Fish Commission, Vol. XII for 1889. This paper also contains the list of the fishes collected in Spadra Creek.

In July and August, 1891, the writer, assisted by Prof. P. H.

Rolfs (Entomologist of the Florida Agricultural Experiment Station), spent five weeks exploring streams in northern Arkansas under the direction of the United States Fish Commissioner. The report of this work will appear in the forthcoming Bulletin of the United States Fish Commission. By permission of the United States Fish Commissioner the results of that work, in so far as they relate to Arkansas are incorporated in the present paper.

Nearly all the collections made in Arkansas are listed in the papers mentioned below. In order to shorten the references to these papers the following abbreviations are used instead of the full titles:

A. Ichthyology, Vol. VI, of the Pacific Railway Survey Report, 1859.

B. Proceedings Academy of Natural Sciences of Philadelphia, 1856 to 1859.

C. Proceedings of the U. S. National Museum, 1886.

D. Jordan & Gilbert's Catalogue of Fishes of North America, 1885.

E. Proceedings of the U. S. National Museum, 1888.

M. D. S. Jordan's Manual of Vertebrates, 1888.

O. Bulletin of the U. S. Fish Commission, Vol. IX, 1891.

P. Bulletin of the U. S. Fish Commission (forthcoming).

References to other papers are given in full.

Under *habitat* is given the distribution of each species. A few notes are also added concerning habits, value, etc. of most of the species.

A few species that have not yet been found in this state, but which, judging from their known geographical distribution, may be looked for here, are mentioned in foot-notes.

A CATALOGUE

OF THE

FISHES OF ARKANSAS.

BY SETH EUGENE MEEK, PH. D.,
Adjunct Professor of Biology and Geology in the Arkansas Industrial University.

CLASS A. CYCLOSTOMI. (The myzonts.)

ORDER I. HYPEROARTIA.

FAMILY I. PETROMYZONTIDÆ. (The lampreys.)

I. PETROMYZON (Artedi) Linnæus.

1. *Petromyzon concolor* (Kirtland). Small river lamprey.
Ichthyomyzon hirudo Girard, **A.** 382; Ft. Smith.
Petromyzon concolor et castaneus Jordan, **D.** 4 (9,10).

Habitat.—Lake Erie to Minnesota, south to Kansas, Arkansas and Louisiana.*

The adult lampreys are parasitic upon the larger fishes. They attach themselves to their victims by means of their subcircular suctorial mouth, rasp off the flesh with their lingual teeth, and feast upon the blood and lymph.

The lampreys assend the smaller streams in the spring for the purpose of depositing their eggs. During this time they are easily taken in large numbers. At other times of the year they are seldom taken except when attached to some unlucky

*For a full discussion of the North American species of lampreys, see Jordan and Fordice, American Acad. Nat. Sci., N. Y., 1886, 279.

fish. Our inland species are all small, and of no economic importance.*

CLASS B. PISCES. (The true fishes).

SERIES GANOIDEI. (The ganoid fishes.)

ORDER 2. SELACHOSTOMI.

FAMILY 2. POLYODONTIDÆ. (Paddle fishes.)

2. POLYODON (Lacépède) **B.** and **G.**

2. *Polyodon spathula* (Walbaum). Paddle-fishes; spoon-bill duck-billed cat.

Polyodon spathula Jordan, **D.** 13 (100); **M.** 31; Meek, **P.** White River, Oxford Bend near Fayetteville.

Habitat.—Mississippi Valley.

This species is peculiar to the Mississippi Valley. It inhabits only the larger streams and bayous. It feeds upon minute organisms which it stirs up from the mud with its oar-like snout.

The numerous and fine gill rakers act as strainers to separate insects, crustaceans, etc., from the silt of the river bottom.

This species attains the length of about six feet. As a food fish it is inferior. A large specimen is reported to have been caught in a fish trap on White River near Oxford Bend, Washington county, in the spring of 1892.

FAMILY 3. ACIPENSERIDÆ. (The sturgeons.)

3. SCAPHIRHYNCHUS Hæckel.

3. *Scaphirhynchus platyrhynchus* (Rafinesque). Shovel-nosed sturgeon; white sturgeon.

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*AMMOCŒTES Dumeril.

Ammocœtes branchialis (Linnæus). Mud-lamprey; brook-lamprey.

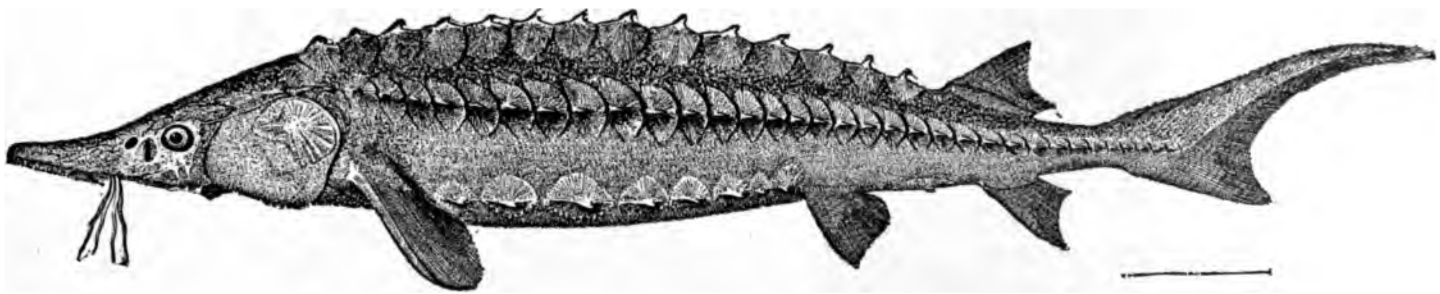
Ammocœtus æpypterus Jordan, **D.** 4, (7).

Ammocœtus branchalis Jordan. **M.** 10.

Habitat.—Western N. Y. to Minnesota and Kentucky.

This species, known only from a few widely distributed localities, may also be a resident of Arkansas.

PLATE I.



LAKE STURGEON; ROCK STURGEON.
Acipenser rubicundus Le Sueur. (Page 223).

Scaphirhynchus platyrhynchus Girard, **A**. 357.
Near the mouth of the Poteau River.
Jordan and Gilbert, **C**. 14, Fulton.
Jordan, **M**. 34; **D**. 13 (106).

Habitat.—Mississippi Valley.

This species inhabits only the largest streams and bayous. The character of its food is little known. It consists for the most part of such organic material as can be sucked up by its inferior toothless mouth.

They are occasionally taken with the hook baited for suckers. This species reaches a length of about five feet. It is of little value as a food fish.

4. ACIPENSER (Artedi) Linnæus.

4. *Acipenser rubicundus* Le Sueur. Lake sturgeon; rock sturgeon.

Acipenser rubicundus Jordan, **D**. 13 (104); **M**. 34.

Habitat.—Mississippi Valley, the Great Lakes and northward.

This is one of our largest fresh-water fishes. It inhabits only the largest streams and lakes, ascending smaller streams in the spring to deposit its spawn. Its food consists of shellfish. Eggs of other species are also found in its stomach, but it is probable that fish-spawn is not one of its chief articles of food.

" The long protecting sucker mouth situated almost under the center of the head will sometimes suck in the anglers baited hook, in which case, one may as well try to snub an old log. It is, however, possible to coax him to move occasionally, and then you may or you may not, succeed in bringing him to gaff. As game fish the sturgeon is not a success."—Hallock.

The same characteristics belong to the preceding species, but when it is landed it is not outdone in fighting qualities by any of the game fishes.

The rock sturgeon reaches a length of five or six feet, and is regarded as a very good food fish.

FAMILY 4. LEPISOSTEIDÆ. (The gar pikes.)

5. LEPISOSTEUS Lacépède.

5. *Lepisosteus osseus* (Linnæus) common gar pike; long-nosed gar; bill fish.

Lepisosteus osseus Jordan & Gilbert, **C.** Ft. Smith; **C.** 14, Fulton; Jordan, 13 (107); **M.** 35; Meek, **P.** Arkansas River at Little Rock and Mulberry; Strawberry River at Smithville; Little Red River at Judsonia.

Habitat.—Great Lakes to the Carolinas and Mexico.

The gar pikes live only in the larger streams and lakes. In the early spring they ascend smaller streams to deposit their spawn, during this time large numbers can frequently be seen below dams attempting to get further up stream. When the water is cool, they become slow and sluggish in their movements, and are easily gilled in nets. The fishermen in this way take and destroy large numbers every fall.

The gars are all carniverous, they thus consume each year large quantities of minnows, other small fishes, and crustaceans, which would serve a better purpose if converted into black bass, pickerel, etc.

As food fishes or food for food fishes, the gars are usually regarded as worthless. I have, however, given large specimens to negroes on the Arkansas River who preferred them to cat fish.

This species reaches a length of about three feet. It is easily distinguished from the next two species by its long narrow snout, it being several times as long as broad, and more than twice the length of the rest of the head. In the other two species the snout is broad and but little longer than the rest of the head.

6. *Lepisosteus platystomus* Rafinesque. Short-nosed gar pike.

Lepisosteus platystomus Jordan, **D.** 13 (108); **M.** 36; Jordan and Gilbert, **C.** 6, Ft. Smith.

Habitat.—Michigan and Mississippi Valley.

Similar in habits to the preceding, but smaller in size.

7. *Lepisosteus tristœchus* (Bloch and Schneider). Alligator gar.

Lepisosteus tristœchus Jordan and Gilbert, **C**. 6, Ft. Smith. Jordan, **D**. 13 (109); **M**. 36.

Habitat.—Illinois to Mexico and Cuba.

This species is found only in the largest streams. It is one of the largest, if not the largest of our fresh-water fishes. It reaches a length of ten feet. Large specimens were observed in the White River at Newport in 1891. It has also been taken in the Ouachita and in the Red River. It seems to be numerous in the larger Arkansas rivers.

ORDER 3. HALECOMORPHI.

FAMILY 5. AMIIDÆ. (The bow-fins.)

6. AMIA Linnæus.

8. *Amia calva* Linnæus. Bow-fin; mud fish; dog fish.

Amia calva Jordan, **D**. 13 (110); **M**. 37. Meek, **P**. Bull creek at Beebe, Arkansas.

Habitat.—Vermont to Dakota, Florida and Mexico.

This species inhabits swamps, lakes and bayous. It also loiters among the weeds along the banks of slow flowing streams. It is omnivorous with a preference for crustaceans and the like. Its flesh is soft and pasty and of no value as food. This fish, like all generalized types, is of great interest to the naturalist. Its length seldom exceeds eighteen inches.

ORDER 4. NEMATOGNATHI.

FAMILY 6. SILURIDÆ. (The cat fishes.)

7. ICTALURUS Rafinesque.

9. *Ictalurus furcatus* (Cuv. and Val.). Chuckle-headed cat.

Ictalurus furcatus Jordan, **D**. 15 (135); **M**. 39. Meek, **P**. Arkansas River.

Habitat.—Mississippi Valley.

Similar in appearance and habits to the following species. It inhabits only rivers and large bodies of water. As a food fish it is excellent.

10. *Ictalurus punctatus* (Rafinesque). Channel cat; white cat; silver cat.

Pimelodus olivaceous Girard, **A.** 211, Arkansas River near Fort Smith.

Ictalurus punctatus Jordan and Gilbert, **C.** 2, Eureka Springs; **C.** 7 Ft. Smith; **C.** 10, Arkadelphia and Benton; **C.** 14 Fulton. Jordan, **D.** 15 (134); **M.** 39. Meek, **O.** 127, Spadra Creek at Clarksville; Meek, **P.** Arkansas River at Little Rock and Mulberry; White River at Batesville and Oxford Bend; Strawberry River at Smithville; Mulberry River at Mulberry.

Habitat.—Montana to Vermont, Georgia and Mexico.

This species inhabits the channels of rivers and larger creeks. It lives chiefly upon fishes, bivalve mollusks and aquatic larvae, insects, worms, etc. This species seldom exceeds three feet in length. As a food fish it is not distinguished from the preceding.

8. AMEIURUS Rafinesque.

11. *Ameiurus lacustris* (Walbaum). Great cat fish; Mississippi cat; blue cat.

Ameiurus nigricans Jordan, **D.** 15 (132); **M.** 39. Meek, **P.** White River at Oxford Bend.

Habitat.—Ontario to Florida and Texas.

This is our largest cat fish, specimens have been taken weighing over two hundred pounds. It inhabits only large lakes and rivers. It is omnivorous and belongs to a genus of scavengers. As a food fish it is scarcely inferior to the channel cat, although it is much more extensively used for food than the channel cat. One specimen weighing 67 pounds has been taken on a fish trap at Oxfod Bend near Fayetteville.

12. *Ameiurus natalis* (Le Sueur). Yellow cat.

Pimelodus felinus Girard, **A.** (No. 5, 52), 209, Coal Creek, Ark.

Ameiurus natalis Jordan and Gilbert, **C.** 7, Ft. Smith. Jordan, **D.** 15 (127); **M.** 40.

Habitat.—This and the following species of this genus seldom reaches a length of two feet. The species are all valuable and rank fairly well as food fishes, especially when not taken from warm stagnant pools. The objection to them as food fishes is the small size of the body and comparatively large head.

13. *Ameiurus nebulosus* (Le Sueur). Common bull-head; horned pout.

Ameiurus nebulosus Jordan, **D.** 14 (125); **M.** 40. Meek, **O.** 133, Bayou of Spring River and English Creek at Mammoth Spring; Meek, **P.** South Fork of Little Red River at Kinderhook.

Habitat.—New England to Wisconsin, Virginia and Texas. Also introduced into the rivers of California.

The bull-head spawns in the spring. The old one cares for her young pretty much as a hen cares for her chickens. Often in the spring in shallow water an old one may be seen lying on the ground with large numbers of young swiming around her. This maternal affection is not generally characteristic of fresh-water fishes.

"The horned pout is a dull and blundering fellow vespertinal in its habits and fond of the mud. It bites deliberately as if about its business. They are extremely tenaceous of life, opening and shutting their mouths for half an hour after their heads have been cut off. A blood-thirsty and bullying race of rangers inhabiting the river bottoms, with ever a lance at rest and ready to do battle with their nearest neighbor. I have observed them in the summer, when every other one had a scar on his back, where the skin was gone, the mark of some fierce encounter. Sometimes the fry not an inch long are seen darking the shores with their myriads."—Thoreau.

14. *Ameiurus melas* (Rafinesque).

Pimelodus catulus Girard, **A**. 209 (No. 5, 52), Ft. Smith.

Ameiurus melas Jordan, **D**. 14 (124); **M**. 41. Meek, **O**. 133, Myatt Creek at Mammoth Spring. Meek, **P**. Spring Creek near Batesville; East Fork of Cadron at Conway; Illinois River at Ladd's Mill and Prairie Grove; Polk Bayou at Batesville; Little Red River at Heber; Black River at Black Rock and Bull Creek at Beebe.

Habitat.—New York to Minnesota, Kansas and Arkansas.

This species very much resembles the preceding. It is smaller, has about 19 anal rays. The anal rays are pale with a dusky membrane between them. This form is most abundant north and west and southwest.

9. Leptops Rafinesque.

15. *Leptops olivaris* (Rafinesque). Mud cat; flat-headed cat; Russian cat.

Leptops olivaris Jordan and Gilbert, **C**. 7, Ft. Smith; **C**. 14, Fulton. Jordan, **D**. 14 (120); **M** 41. Meek, **P**. Arkansas River at Little Rock and Mulberry; East Fork of Cadron at Conway; Cove Creek at Martinsville; White River at Oxford Bend.

Habitat.—Ohio to Georgia and southwest.

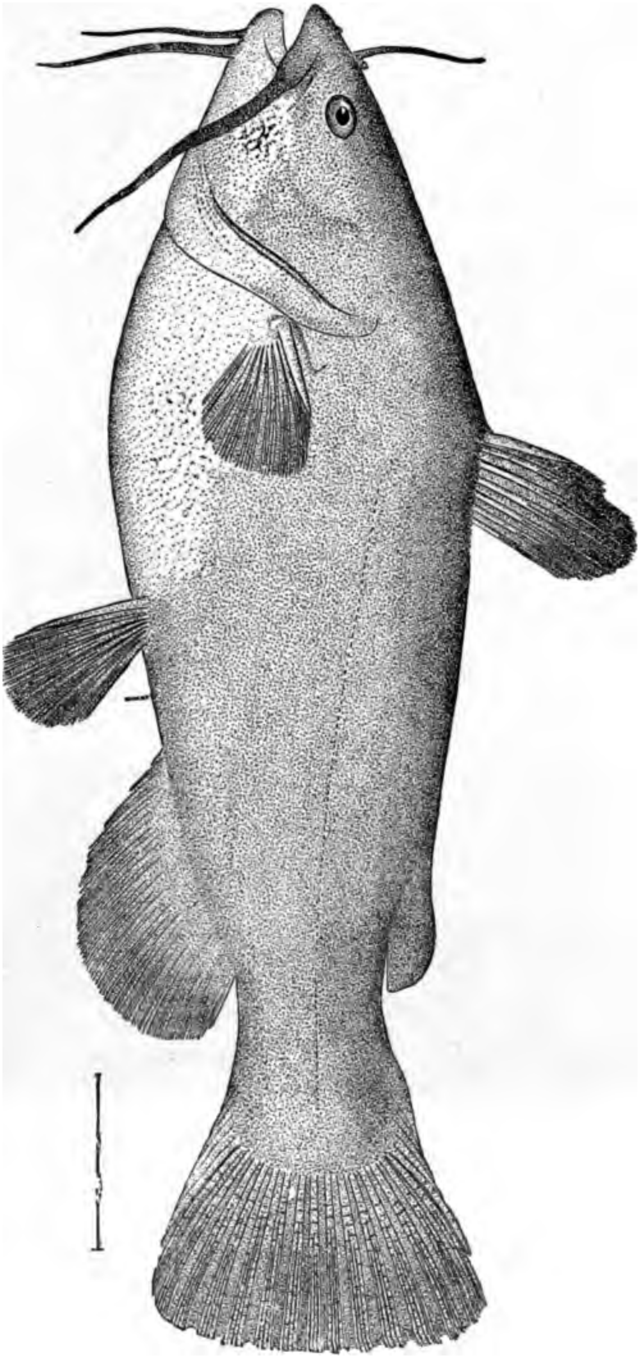
This is our second largest cat fish. It sometimes reaches the weight of 75 pounds; it is omnivorous and loves the mud. As a food fish it ranks well.

This species can always be distinguished from *A. nigricans*, which it resembles in size, by the shorter anal fin (12 to 15 rays) and by the backward extension of the upper teeth.

10. Noturus Rafinesque.

This genus consists of small fishes which abound in brooks among the logs and weeds. The largest seldom reaches a length of twelve or fifteen inches.

PLATE III.



SMALL BLACK BULL HEAD.
Ameiurus melas (Rafinesque.) (Page 228.)

This genus is characterized by the rounded caudal fin, the yellow color, and by the adipose fin which is adnate to the back for its entire length. "The wounds produced by the sting of the sharp pectorals are excessively painful. In the axil is usually a pore probably the opening of a duct from some poison gland. This matter deserves investigation."—Jordan.

Their food consists mostly of insect larvæ and small crustacea. None of the species are of economic importance.

16. *Noturus flavus* (Rafinesque).

Noturus flavus Jordan and Gilbert, **C.** 7, Ft. Smith. Jordan, **D.** 14 (119); **M.** 41. Meek, **P.** Illinois River at Prairie Grove, and Ladd's Mill; Jordan's Creek and Barren Fork at Dutch Mills.

Habitat.—Ontario to Virginia, Arkansas and Tennessee.

17. *Noturus miurus* Jordan.

Noturus miurus Jordan and Gilbert, **C.** 2, Eureka Springs; **C.** 6, Ft. Smith; **C.** 10, Arkadelphia and Benton. Jordan, **D.** 14 (116); **M.** 42.

Habitat.—Minnesota to Arkansas and Louisiana.

18. *Noturus nocturnus* Jordan and Gilbert.

Noturus nocturnus Jordan and Gilbert, **C.** 6, Ft. Smith, (Description). **C.** 10, Arkadelphia and Benton. Jordan, **D.** 14 (113). Meek, **O.** 138, Ouachita and Saline Rivers; Meek, **P.** Spring River at Black Rock; Middle Fork of White River at Fayetteville; White River at Oxford Bend.

Habitat.—Southern Indiana and Arkansas.

This species was first discovered in Arkansas in 1884 by Drs. Jordan and Gilbert.

19. *Noturus gyrinus* (Mitchill).

Noturus gyrinus Jordan, **D.** 14 (111); **M.** 42.

Habitat.—Hudson River to Dakota and Louisana.

ORDER 5. EVENTOGNATHI.

FAMILY 7. CATOSTOMIDÆ. (The Suckers.)

11. ICTIOBUS Rafinesque.

The species of buffalo fishes are variable and the number of species, at present is uncertain. "They are large, coarse suckers, especially characteristic of the Mississippi Valley. The group is very much in need of careful study, such as could be given by a collector resident near some large market."—Jordan.

The following species no doubt occur in Arkansas, or at least as many of them as are enumerated below.

The larger only, inhabit the deeper waters, and it is difficult to obtain moderately small specimens.

The buffalo fishes seem quite common in the larger streams and bayous of this state. I have not had the opportunity to visit any of our large markets, and am unable to identify with certainty any of the very few larger specimens. The list given below probably does not include all the species of the genus found in the state. The buffalo fishes as food fishes are of mediocre quality.

20. *Ictiobus cyprinella* (Cuv. and Val.). Common buffalo fish; red-mouthed buffalo.

Ictiobus cyprinella Jordan, **D.** 16 (144); **M.** 44.

Habitat.—Mississippi Valley.

This species seems to prefer deep bayous to the river currents.

The buffalo fishes are inclined to be omnivorous, and are considered by some as scavengers. Their food consists mostly of gasteropods, insects, crustaceans, worms, and various forms of fresh water algæ. The buffalo fishes are said by Prof. Forbes to frequent the mouths of gutters and to feed upon the distillery slops. This species is used extensively for food; though its flesh is coarse and full of small bones. It reaches a weight of 30 pounds.

21. *Ictiobus bubalus* (Rafinesque). Sucker-mouthed buffalo; small-mouthed buffalo.

Ictiobus bubalus Jordan and Gilbert, **C**. 14, Fulton. Jordan, **D**. 16 (146); **M**. 44.

Habitat.—Mississippi Valley.

This species is perhaps more abundantly used for food than any of the other buffalo fishes. It prefers running water.

22. *Ictiobus urus* (Agassiz). Razor-backed buffalo; mongrel buffalo.

Ictiobus urus Jordan, **D**. 16 (145); **M**. 45.

Habitat.—Mississippi Valley.

This species is similar to *I. cyprinella*.

23. *Ictiobus carpio* (Rafinesque).

Ictiobus carpio Jordan, **D**. 16 (147); **M**. 45.

Habitat.—Ohio Valley to Texas.

"Probably a valid species, but of doubtful name and synonomy."—Jordan.

24. *Ictiobus difformis* (Cope).

Ictiobus difformis Jordan, **M**. 45.

Habitat.—Mississippi Valley.

25. *Ictiobus velifer* (Rafinesque). Quill-back; skim-back; carp sucker.

? *Carpiodes damalis* Girard, **B**. 1856, 70, Ft. Smith.

Ictiobus velifer Jordan and Gilbert, **C**. 7, Ft. Smith; **C**. 10, Arkadelphia and Benton; **C**. 14, Fulton. Jordan, **D**. 16 (148); **M**. 45. Meek, **O**. 127; Spadra creek at Clarksville; Meek, **P**. Arkansas River at Little Rock; White River at Oxford Bend; Arkansas River at Little Rock and Mulberry; Little Red River at Judsonia; Illinois Creek at Russellville; East Fork Cadron at Conway.

Habitat.—Mississippi Valley.

This is a very abundant species of the genus, and is perhaps the least used for food. It inhabits smaller streams than do the others. It is a very variable species.

12. CYCLEPTUS Rafinesque.

•26. *Cycleptus elongatus* (Le Sueur). Missouri sucker; black-horse; gourd-seed sucker.

Cycleptus elongatus Jordan, **D.** 17 (150); **M.** 46, Meek, **P.** Spring River at Black Rock.

Habitat.—Mississippi Valley.

This species inhabits only the larger streams. It reaches a length of 2½ feet, and is probably the best food fish in the family. It is never found in large numbers.

13. CATOSTOMUS Le Sueur.

27. *Catostomus teres* (Mitchill). Common sucker; white sucker.

Catostomus teres Jordan, **D.** 18 (170); **M.** 46. Meek, **O.** 133; Spring River at Mammoth Springs.

Catostomus teres Meek, **P.** Middle Fork of White River at Fayetteville; Jordan's Creek at Dutch Mills; Clear Creek at Johnson's; Illinois River at Prairie Grove and Ladd's Mill.

Habitat.—Canada to Montana, Texas and Florida.

This is the most abundant of all the suckers. It inhablts all streams; feeds upon insects, larvæ, crustaceans, and various forms of algæ. As a food fish it is of very little value. In Arkansas this species seems to be less common than in most other localities.

28. *Catostomus nigricans* (Le Sueur). Hog sucker; stone roller; stone lugger; stone toter; hog molly; mullet.

Catostomus nigricans Jordan and Gilbert, **C.** 7, Ft. Smith; **C.** 11, Arkadelphia and Benton. Jordan, **D.** 18 (17); **M.** 46. Meek, **O.** Spring River; Myatt and Spring Rivers at Mammoth Spring; 138, Ouachita and Saline Rivers; Meek, **P.** Black and Spring Rivers at Black Rock; Little Red River near Heber; Middle and South Forks of Little Red

River at Kinderhook; Strawberry River at Smithville; Illinois River at Prairie Grove and Ladd's Mill; Mulberry River at Mulberry; Polk Bayou, Big Spring Creek and Lafferty's Creek near Batesville; King's River at Marble; Big Buffalo near Loafer's Glory; Coon Creek at Martinsville; Devil's Fork south of Red River at Shiloh.

Habitat.—New York to Alabama and Kansas.

This species prefers clear water. As a food fiish it is almost worthless. The character of its food is similar to that of the preceding. It is very abundant in Arkansas, being found in almost all rivers and creeks where the water is clear.

14. ERIMYZON Lacépède.

29. *Erimyzon sucetta* Lacépède. Chub sucker; sweet sucker.

Erimyzon sucetta Jordan, **D.** 19 (179); **M.** 46. Meek, **O.** 127; Spadra Creek at Clarksville; **O.** 133, Spring River and Myatt Creek near Mammoth Spring; **O.** 136, Judsonia; 138, Caddo and Mazarn; **P.** Little Red River near Heber; White River, Spring Creek, Big Spring, Salado and Caney Creek near Batesville; Bull Creek at Beebe; Illinois River at Russellville.

Habitat.—Massachusetts to Dakota and South.

This species seldom reaches a foot in length. It lives upon algæ, diatoms, and such organic matter as it finds in the mud it swallows. As a food fish it has very little value. It lives in bayous and stagnant ponds, and is seldom found in moderately clear water.

15. MINYTREMA Jordan.

30. *Minytrema melanops* (Rafinesque). Striped sucker.

Minytrema melanops Jordan, **D.** 19 (177); **M.** 47. Meek, **P.** Bull Creek at Beebe; Spring Creek near Batesville.

Habitat.—Great Lakes to South Carolina and Texas.

This species is less common south than north. It lives in clear sluggish water and among the weeds. As a food fish it has but little value.

16. MOXOSTOMA Rafinesque.

31. *Moxostoma duquesnei* Le Sueur. Common red horse; mullet.

Moxostoma macrolepidotum Jordan and Gilbert, **C.** 2, Eureka Springs; **C.** 7, Ft. Smith; **C.** 11, Arkadelphia and Benton.

Moxostoma macrolepidotum Jordan, **D.** 19, 1856; **M.** 47.

Moxostoma duquesnei Meek, **O.** 127, Spadra Creek at Clarksville; 133 Spring River, Myatt and English Creeks near Mammoth Spring; 138, Ouachita and Saline Rivers.

Meek, **P.** White River, Spring, Salado and Caney Creeks and Polk Bayou near Batesville; Village Creek at Newport; Illinois river at Ladd's Mill and Prairie Grove; Main and Middle Forks of White River near Fayetteville; Jordan's Creek at Dutch Mills; King's River at Marble; Black and Spring Rivers at Black Rock; Strawberry River, Flat and Machine Creeks at Switchville; Illinois Creek at Russellville; Cove Creek at Martinsville; Devil's Fork of Little Red River at Shiloh.

Habitat.—Chesapeake Bay to Dakota and Alabama.

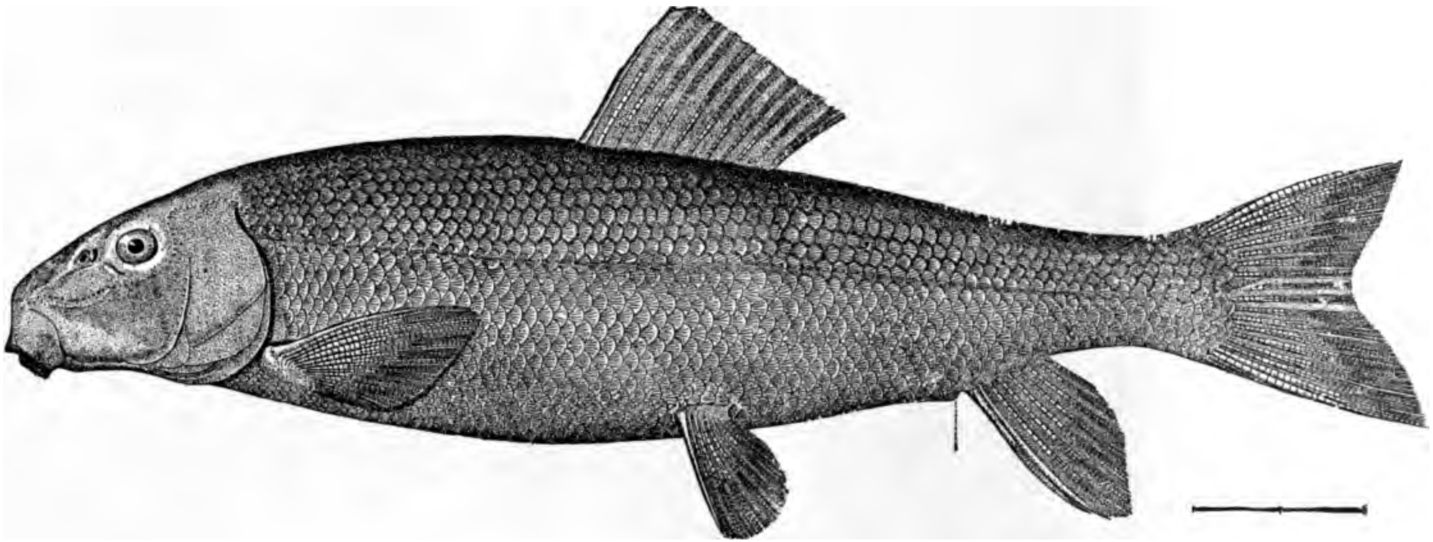
A very variable and common sucker. It prefers clear water. It feeds upon worms, mollusks, algæ, and mud. It seldom reaches a length of two feet, and is of very little value as a food fish.*

**Moxostoma Pœcilurum* Jordan.

Moxostoma pœcilurum Jordan, **D.** 20, (191).

Habitat.—Known only from Louisiana, but it is probably a resident of Southern Arkansas.

PLATE IV.



THE RED HORSE; MULLET.
Moxostoma duquesnei Le Sueur. (Page 234.)

17. PLACOPHARYNX Cope.

32. *Placopharynx carinatus* Cope.

Placopharynx carinatus Jordan and Gilbert, **C.** 2. Eureka Springs; **C.** 7, Ft. Smith: Jordan, **D.** 20 (167); **M.** 48. Meek, **P.** Mulberry River at Mulberry; Cove Creek at Martinville.

Habitat.—Ohio to Iowa, Arkansas and Georgia.

In external characters this species resembles the preceding one. It prefers clear flowing water, and reaches a length of nearly three feet. Although inferior, it is quite extensively used for food.

18. LAGOCHILA Jordan and Brayton.

33. *Lagochila lacera* Jordan and Brayton. Hare-lip sucker.

Quassilabia lacera Jordan and Gilbert, **C.** 2, Eureka Springs. Jordan 20 (194); **M.** 49.

Habitat. Ohio to Georgia and Southwest.

Concerning the habits of this species little is known. It is not large, but is a fairly good food fish.

FAMILY 8. **CYPRINIDÆ.** (The minnows.)

This family comprises nearly all of our smaller fishes known as minnows. They occur in the largest lakes and rivers, but are more numerous in the smaller bodies of water and creeks. They are usually found in large numbers, and owing to the great uniformity in size and coloration the species are difficult to distinguish. The characters upon which genera and species are based are, in most cases, trivial or very variable. Many of the variations are due to age, or are sexual or seasonal. In the spring the males are often highly colored and the snout and body are covered with tubercles. It is impossible to identify species of the very young, and half grown individuals have often been made the types of new species.

These fishes also differ with respect to the character of the water they inhabit. Those always found in clear water are lighter in color than those living among the weeds.

Professor Cope says of them:—"The differences of habit are associated with the peculiarities of food and the structure of the digestive system. Few families of the vertebrates embrace so great a variety in these respects as the present one. There are carnivorous, insectivorous and graminivorous genera, which are also distinguished among the mammalia, the former by the abreviation, the last by the elongation of the alimentary canal. In the former the teeth usually sharp-edged or hooked, in the latter truncate, hammer or spoon-shaped."

While all of these species are too small to be used for food by man, they are all of the utmost importance because they furnish much food for the larger predatory fishes. These little fishes may be regarded as mere machines, swimming about in the water, converting small simple organisms into larger and more complete ones and thus preparing the meals for the voraceous bass, pickerel and the like. They are naturally very timid. In our endeavors to protect the larger game fishes, we cannot afford to forget the minnows.

19. CAMPOSTOMA Agassiz.

34. *Compostoma anomalum* (Rafinesque). Stone lugger; stone roller.

Compostoma anomalum Jordan and Gilbert, **C.** 2, Eureka Springs; **C.** 7, Ft. Smith; **C.** 11, Arkadelphia and Benton. Jordan, **D.** 20 (169); **M.** 52. Gilbert, **E.** 609, Waldron. Meek, **O.** 127, Spadra Creek at Clarksville; 138, Ouachita and Saline Rivers; Meek, **P.** 133, White River, Spring Creek, Big Spring, Lafferty Creek and Polk Bayou near Batesville; Black and Spring Rivers at Black Rock; Strawberry River, Flat and Machine Creeks at Smithville; Mulberry River at Mulberry; Middle Fork of White River near Fayetteville; South and Middle Forks of Little Red River at Kinderhook; Illinois River at Ladd's Mill and Prairie Grove; Big

Buffalo at Loafers' Glory ; Jordan's Creek at Dutch Mills; Cove Creek at Martinsville; Devil's Fork of Little Red River at Shiloh; Illinois Creek at Russellville.

Habitat.—Western New York to Minnesota, Texas and Tennessee.

This species attains a length of about eight inches. Its food consists of organic matter contained in the mud which it swallows in large quantities.*

20. CHROSOMUS Rafinesque.

35. *Chrosomus erythrogaster* Rafinesque. Red bellied minnow.

Chrosomus erythrogaster Jordan, **D**. 20 (202); **M**. 53. Meek, 133, Spring Branch, Mammoth Spring; 138, South Fork Ouachita River. Meek, **P**. Big Spring at Batesville; Big Buffalo at Loafer's Glory; King's River at Marble.

21. HYBOGNATHUS Agassiz.

36. *Hybognathus plumbea* (Girard).

Dionda spadicea Girard, **A**. 229, Ft. Smith.

Zophendum plumbeum Jordan, **D**. 20 (205). Jordan and Gilbert, Syn. Fishes N. A. 1882, 154.

Habitat.—Arkansas and Indian Territory.

37. *Hybognathus nuchalis* Agassiz. Blunt-jawed minnow.

Hybognathus nuchalis Jordan and Gilbert, **C**. 7, Ft. Smith; **C**. 11, Benton; **C**. 14, Fulton. Jordan, **D**. 51 (216); **M**. 53. Meek, **O**. 136. Judsonia; **P**. White River, Salado, Caney and Lafferty Creeks and Polk Bayou near Batesville; Jordan's Creek at Dutch Mills; Illinois River at Ladd's Mill; Little Red River near Heber; Arkansas River at Little Rock

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**Campostoma formosulum* Girard.

Campostoma formosulum Jordan, **D**. 20 (195).

This species is found in Texas and may also be a resident of Arkansas.

and Mulberry; Strawberry River at Smithville; Black and Spring Rivers at Black Rock; East Fork of Cadron at Conway; Illinois River at Russellville; Little Red River at Judsonia.

Habitat.—New Jersey to South Carolina, Dakota and Texas. Length, from four to nine inches; vegetable feeder.

37a. *Hybognathus nuchalis placita* Girard.

Hybognathus placita Girard, **A**. 236 (No. 4, 22), sluice of the Arkansas River near Ft. Smith. Girard, **B**. 1856, Arkansas River. Jordan, **D**. 21 (216b); **M**. 53. Meek, **O**. 136, Judsonia. Meek, **P**. Big Buffalo at Loafer's Glory; King's River at Marble; Illinois River at Prairie Grove; Middle Fork of White River near Fayetteville.

Habitat.—Iowa to Arkansas River.

This variety has a smaller eye and a smaller mouth than the preceding.*

38. *Hybognathus argyritis* (Girard).

Hybognathus argyritis Girard, **A**. 235 (No. 5, 54), Arkansas River near Ft. Smith. **D**. 21 (215). Girard, **B**. 1856, 182, Ft. Smith.

Habitat.—Arkansas and southwest.

39. *Hybognathus nubila* (Forbes).

Hybognathus nubila Jordan and Gilbert, **C**. 2, Eureka Springs. Jordan, **D**. 21 (212, 214); **M**. 53. Meek, **C**. 133. Spring River, Myatt and English Creeks at Mammoth Spring; 138, Saline River; Illinois River at Prairie Grove; King's River at Marble; Big

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**Hybognathus hayi* Jordan.

Hybognathus hayi Jordan, **D**. 22 (217).

Hybognathus argyritis Jordan and Gilbert, Synopsis Fish. N. A. 968.

Habitat.—Lower Mississippi River.

This species known from the streams of Alabama and Mississippi may also be found in the streams of Arkansas.

Buffalo at Loafer's Glory; Middle Fork of White River near Fayetteville.

Habitat.—Illinois to Iowa and Arkansas.

22. PIMEPHALES Rafinesque.

40. *Pimephales promelas* Rafinesque. Black-headed minnow.

Pimephales maculosus Girard, **A.** 234 (No. 4, 22), sluice of the Arkansas River; Girard, **B.** 1856, 180.

Pimephales promelas Jordan, **D.** 22, 218. Meek, **P.** Middle Fork of White River near Fayetteville; Middle Fork of Little Red River at Kinderhook.

Habitat.—Lake Champlain to Dakota and Texas.

This species is very common in sluggish water. It feeds chiefly upon insects. Length, two and a half inches.

41. *Pimephales notatus* (Rafinesque). Blunt-nosed minnow.

Hyborynchus perspicuus Girard, **A.** 231 (No. 5, 53), Arkansas River near Ft. Smith; Girard, **B.** 179, Ft. Smith.

Pimephales notatus Jordan and Gilbert, **C.** 2. Eureka Springs; **C.** 7. Ft. Smith; **C.** 11, Benton. Jordan, **D.** 22 (219); **M.** 54. Gilbert, **E.** 609, Waldron. Meek, **O.** Spadra Creek at Clarksville; 133, Warm Fork and Myatt Creek at Mammoth Spring; 138, Ouachita and Saline Rivers. Meek, **P.** White River, Salado, Caney and Lafferty Creeks, and Polk Bayou near Batesville; Strawberry River and Flat and Machine Creeks at Smithville; Mulberry River at Mulberry; Illinois River at Ladd's Mill and Prairie Grove; Walnut Creek at Swain; King's River at Marble; Middle and Main Forks of White River near Fayetteville; Jordan's Creek at Dutch Mills; Big Buffalo at Loafer's Glory; Little Red River at Heber; Illi-

nois River at Russellville; Cove Creek at Martinsville; Devil's Fork and Middle Fork of Little Red River at Kinderhook.

Habitat.—Quebec to Delaware, Mississippi, Arkansas and Dakota.

This species lives in clear running water; its food consists of vegetation and organic matter found in the mud. Length four inches.

23. CLIOLA Girard.

42. *Cliola vigilax* (Baird and Girard). Bull-head minnow.
Cliola vigilax Girard **A.** 257, Otter Creek.
Girard, **B.** 1856, 192, Otter Creek.
Jordan and Gilbert, **C.** 7, Ft. Smith. Jordan **D.** 22 (223). Meek, **P.** Arkansas River at Little Rock and Mulberry; White River, Salado and Caney Creeks near Batesville; Black River at Black Rock; East Fork of Cadron Creek at Conway.

Habitat.—Indiana to Mississippi, Texas and Dakota.

This species very much resembles *P. notatus* in size, form and habits.

24. NOTROPIS Rafinesque.

This genus cromprises many species. All small, feeble and of low organization.

This genus has been divided into many genera, but the characters upon which each was based were subject to intergradations. The larger the number of specimens studied the weaker became the permanancy of these characters, until of late years all are put under the one genus.

These small fishes inhabit almost entirely small streams and lakes. They are seldom found in the river currents or in deep water. They seem to migrate but little, and thus many local varieties have arisen.

It is difficult to identify the species of this group; they are chiefly omnivorous, and are valuable only as they serve as food for larger predatory fishes.

43. *Notropis heterodon* (Cope).

Notropis heterodon Jordan, **D.** 22 (226); **M.** 55. Gilbert, **E.** 609, Waldron. Meek, **P.** White River and Lafferty Creek near Batesville; Little Red River at Heber; Illinois River at Prairie Grove; Black River at Black Rock; Main Fork of White River near Fayetteville.

Habitat.—Western New York to Minnesota and Arkansas.

One of our smaller fishes, it lives in weedy places. Length two and a half inches.

44. *Notropis cayuga* (Meek).

Notropis cayuga Meek. Annals of the New York, Acad. Sciences, Vol. LV., 1888, 305. (Description.)

Habitat.—New York to Dakota, south to Arkansas.

This species is found usually with *N. heterodon* which it much resembles.

45. *Notropis illecebrosus* (Girard).

Alburnops illecebrosus Girard, **B.** 1856, Arkansas River at Ft. Smith; Girard, **A.** 262 (No. 5, 56), Ft. Smith.

Notropis illecebrosus Jordan and Gilbert, **C.** 7, Ft. Smith.

Notropis illicebrosus Jordan, **D.** 23 (229); Jordan, Proc. U. S. Nat. Museum, 1885, 123. (Description.)

Habitat.—Western Arkansas.*

**Notropis longirostris* (Hay).

Alburnops longirostris Hay, Proc. U. S. Nat. Museum, 1880, 504. (Description.)

Notropis longirostris Jordan, **D.** 23; (231).

Habitat.—Chickasawha River, Mississippi.

Possibly an Arkansas resident.

46. *Notropis deliciosus* (Girard).

Notropis deliciosus Jordan, **D.** 23, (233); **M.** 56. Meek, **P.** Black River at Black Rock.

Habitat.—Great Lakes to Dakota and Texas.

A variable and widely distributed species.

47. *Notropis ozarkana* Meek.

Notropis ozarkana Meek, **O.** 129, Cabool Missouri; Meek, **P.** Strawberry River at Smithville.

Habitat.—Ozark region.

48. *Notropis boops* Gilbert.

? *Notropis shumardi* Girard, **A.** 261 (No. 5,56), Arkansas River at Ft. Smith.; Girard, **B.** 1856, 194, Arkansas River at Ft. Smith.

Notropis scabriceps Jordan and Gilbert, **C.** 3, Eureka Springs; **C.** 7, Ft. Smith; **C.** 11, Arkadelphia and Benton.

Notropis boops Jordan, **D.** 24 (243); **M.** 57. Meek, **O.** 127, Spadra Creek at Clarksville; Ouachita River and its tributaries; Meek **P.** White River and Polk Bayou near Batesville; Rittle Red River at Heber; Middle Fork of Little Red River at Kinderhook; Devil's Fork of Little Red River at Shiloh; Meek, **P.** Strawberry River, Flat and Machine Creeks at Smithville; Illinois River at Paririe Grove and Ladd's Mill; King's River at Marble; Walnut Creek at Swain; Big Buffalo at Loafer's Glory; Black River at Black Rock; Jordan's Creek at Dutch Mills; Middle and Main Forks of White River near Fayetteville; Cove Creek at Martinsville; Illinois Bayou at Russellville.

Habitat.—Southern Indiana to Iowa and Arkansas.

This is one of the most abundant of the minnows of Arkansas. It inhabits clear running water.

49. *Notropis blennius* (Girard).

Alburnops blennius Girard, 261 (No. 5, 55), Arkansas River at Ft. Smith; **B.** 1856, 194, Arkansas River at Ft. Smith. Jordan, **D.** 24 (244).

Habitat.—Arkansas River.

50. *Notropis bubalinus* (Baird and Girard).

Cyprinella bubalina Girard, **A.** 265, Otter Creek; **B.** 1856, 197, Otter Creek.

Cyprinella umbrosa Girard, **A.** 266, Coal Creek, Arkansas.

Cyprinella beckwithi Girard, **A.** 267, sluice of Arkansas River near Ft. McKee; Girard, **B.** 1856, 198, Arkansas River at Ft. McKee.

Notropis bubalinus Jordan, **D.** 25 (253).

Habitat.—Arkansas and Red Rivers.

51. *Notropis galacturus* Cope.

Notropis galacturus Jordan and Gilbert, **C.** 2, Eureka Springs. Jordan, **D.** 25 (262); **M.** 58. Meek, **P.** Spring River, Myatt and English Creeks at Mammoth Spring; Meek, **P.** Lafferty Creek and Polk Bayou near Batesville; Strawberry River at Smithville; Spring and Black Rivers at Black Rock; Main Fork of White River near Fayetteville.

Habitat.—Ozark region, east to eastern Tennessee and Savannah Rivers. Cool, clear water. Length six inches.

52. *Notropis cercostigma* (Cope).

Notropis venustus Jordan and Gilbert, **C.** 14, Fulton. Jordan, **D.** 25 (259).

Cliola venusta Jordan and Gilbert, Syn. Fish. N. A. 1882, 178. (Description.)

Habitat.—Mississippi River to Texas.

53. *Notropis lutrensis* (Baird and Gilbert).

Moniana lutrensis Girard, **A.** 272, Otter Creek; **B.** 1856, 199, Otter Creek.

Moniana pulchella Girard, 275, (No. 5, 58), Sugar Loaf

Creek; Arkansas River near Ft. Smith; Girard, **B.** 1856, 200, Sugar Loaf Creek.

Notropis lutrensis Jordan and Gilbert, **C.** 8, Ft. Smith; **D.** 24 (249); **M.** 57. Meek, **O.** 133, Warm Fork at Mammoth Spring; Meek, **P.** Arkansas River at Little Rock and Mulberry, Mulberry River at Mulberry.

Habitat.—Southern Illinois to the Rio Grande.

54. *Notropis whipplei* (Girard). Silver fin.

Cyprinella whipplei Girard, **A.** 270 (No. 5, 57), Sugar Loaf Creek; Girard, **B.** 1856, 198, Sugar Loaf Creek and Ft. Smith.

Notropis whipplei Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 11, Arkadelphia and Benton. Meek, **O.** 128, Spadra Creek at Clarksville; **O.** 136, Judsonia; **O.** 138, Mazarn, Ouachita and Saline Rivers; Meek, **P.** White River, Polk Bayou, Salado, Caney and Lafferty Creeks near Batesville; Little Red River at Heber and Judsonia; Middle Fork of Little Red River at Kinderhook; Devil's Fork of Little Red River at Shiloh; Walnut Creek at Swain; Middle and Main Forks of White River near Fayetteville; Cadron and Cove Creeks north of Conway; Arkansas and Mulberry Rivers at Mulberry; Illinois Bayou at Russelleville.

Habitat.—Western New York to Virginia, Minnesota and Arkansas.

Very abundant in clear running water. Length four inches.

55. *Notropis camura* (Jordan and Meek).

Cliola camura Jordan and Meek, Proc. U. S. Nat. Mus. 1884, 474. (Description.)

Notropis camura Jordan, 25 (263). Meek, **P.** White River and Polk Bayou at Batesville; Black and Spring Rivers at Black Rock; Little Red River at Judsonia.

Habitat.—Arkansas and Missouri.

56. *Notropis megalops* (Rafinesque). Common shiner; redfin; dace.

Notropis megalops Jordan and Gilbert, **C.** 4, Eureka Springs; **D.** 26 (273); **M.** 58. Meek, **O.** 228, Spadra Creek at Clarksville; **O.** 133, Spring River, Myatt and English Creeks at Mammoth Spring; 138, Caddo, Mazarn and Saline Rivers; 136, Judsonia; Meek, **P.** Big Spring, Polk Bayou, Spring, Lafferty, Salado and Caney Creeks near Batesville; King's River at Marble; Illinois River at Prairie Grove and Ladd's Mill; Big Buffalo at Loafer's Glory; Strawberry River, Flat and Machine Creeks at Smithville; Black and Spring Rivers at Black Rock; Bull Creek at Beebe; Middle Fork of White River near Fayetteville.

Habitat.—In all streams from Maine to the Rocky Mountains, except those of the Carolinas and Texas.

This species is very widely distributed. It is very abundant and variable. Several varieties are recognized and the larger the number of individuals studied, the greater are the opportunities to increase the number of varieties. As a rule it may be said that those varieties predominate in Missouri and Arkansas which have enlarged scales between nape and dorsal fin. In Iowa and Minnesota those which have reduced scales before dorsal fins predominate. Whether the same is true of specimens found east of the Mississippi I am unable to say. It is the largest species of the genus, reaching a length of eight inches or more.

57. *Notropis zonatus* (Agassiz).

Notropis zonatus Jordan and Gilbert, **C.** 2, Eureka Springs. (Description.) Jordan, **D.** 26 (275); **M.** 59. Meek, **O.** Spring River, Myatt and English Creeks at Mammoth Spring; Meek, **P.** Lafferty Creek, Polk Bayou and Spring Creek at Batesville; Big

Buffalo at Loafer's Glory; Jordan's Creek at Dutch Mills; King's River at Marble; Middle Fork of White River near Fayetteville; Illinois River at Prairie Grove and Ladd's Mill.

Habitat.—Ozark region.

This species seems characteristic of the Ozark region. It is found in large numbers in clear running water. It resembles the preceding very much in form and size, the resemblance being greater in the young. This species is more highly colored than any other of the genus in the Ozark region.*

58. *Notropis umbratilis* (Girard).

Alburnus umbratilus Girard, **A**. 260 (No. 5, 55), Sugar Loaf Creek; Girard, **B** 1856, 193, Arkansas River at Fort Smith.

Notropis umbratilus Jordan and Gilbert, **C**. 7, Fort Smith; **C**. 11, Arkadelphia and Benton.

Notropis umbratilis Gilbert, **E**. 609, Waldron. Meek **O**. 133, Spring River at Mammoth Spring; 136, Judsonia; 138, Ouachita, Caddo and Saline Rivers; Meek, **P**. White River, Polk Bayou, Salado, Caney and Spring Creeks and Big Spring, near Batesville; Village Creek at Newport; Cadron and Cove Creeks north of Conway; Little Red River at Judsonia; Flat and Machine Creeks at Smithville.

Habitat.—Illinois to Kansas and Arkansas.

A locally abundant and very variable species. Length about three inches.

59. *Notropis dilectus* (Girard).

Alburnus dilectus Girard, **A**. 259 (No. 5, 55), Arkansas

***Notropis jejunus* (Forbes).

Notropis jejunus Jordan. **D**. 26 (288); **M**. 60.

Habitat.—Pennsylvania to Iowa and Kansas.

This species probably inhabits the streams of Arkansas.

River near Ft. Smith; Girard, **B.** Arkansas River at Ft. Smith.

Notropis dilectus Jordan and Gilbert, **C.** 7, Ft. Smith; **C.** 11, Benton; **C.** 14, Fulton. Jordan, **D.** 27 (399); **M.** 61.

Notropis rubrifrons Meek, **O.** 134, Warm Fork and English Creeks at Mammoth Spring; Meek, **P.** Illinois River at Prairie Grove and Ladd's Mill; Black River at Black Rock; Arkansas River at Mulberry; Middle Fork of White River near Fayetteville; Cadron Creek north of Conway; Jordan's Creek at Dutch Mills; Lafferty Creek at Batesville.

Habitat.—Ohio to Nebraska and Arkansas.

This species belongs to a group of a genus, the species of which are not well defined. They are more or less highly colored during the breeding season; they live in currents or in clear water. They are long and slender, and the most graceful species of the genus. A comparison of a large number of specimens from widely separated localities is much needed.

60. *Notropis telescopus arcansanus* Meek.

Notropis telescopus arcansanus Meek, **O.** 133, Mammoth Spring; Meek, **P.** Lafferty, Salado, and Caney Creeks near Batesville; Main Fork of White River at Fayetteville.

Habitat.—Southern Missouri and northern Arkansas.

61. *Notropsis atherinoides caddoensis* Meek.

Notropis atherinoides caddoensis Meek, **O.** 136, Judsonia; 138, Caddo and Ouachita Rivers and Mazarn Creek; Meek, **P.** White River Salado, Caney and Lafferty Creeks and Polk Bayou near Batesville; Black and Spring Rivers at Black Rock; Cove Creek at Martinsville; Little Red River at Judsonia and Heber; Illinois Bayou at Russellville; Village Creek at Newport.

Habitat.—Ozark region.

62. *Notropis micropteryx* (Cope).

Notropis micropteryx Jordan and Gilbert, **C**. 4, Eureka Springs. Jordan, **D**. 27 (311); **M**. 62.

Habitat.—Ozark region and east to eastern North Carolina.

25. PHENACOBIUS Cope.

63. *Phenacobius mirabilis* (Girard).

Exoglossum mirabile Girard, **A**. 256 (Nos. 4,23 and 5,55), Arkansas River near Ft. Smith; Girard, **B**. 1856, 191, Arkansas River near Ft. Smith.

Phenacobius mirabilis Jordan and Gilbert, **C**. 8, Ft. Smith; **D**. 27 (316). Jordan, **M**. 63.

Habitat.—Illinois River to northern Texas and Dakota.*

26. HYBOPSIS Agassiz.

64. *Hybopsis amblops* (Rafinesque).

Hybopsis amblops Jordan and Gilbert, **C**. 4, Eureka Springs; **C**. 8, Ft. Smith. Jordan, **D**. 29 (331); **M**. 64. Meek, **O**. 134, English Creek at Mammoth Spring; Meek, **P**. White River and Polk Bayou at Batesville; Illinois River at Ladd's Mill and Prairie Grove; Middle Fork of White River near Fayetteville.

Habitat.—Ohio Valley to Alabama and Arkansas.

65. *Hybopsis dissimilis* (Kirtland).

Hypopsis dissimilis Jordan and Gilbert, **C**. 11, Arkadelphia and Benton. Jordan, **D**. 29 (333); **M**. 64. Meek, **O**. 138, Ouachita River; Meek, **P**. Middle Fork of Little Red River at Kinderhook; White River at Batesville.

Habitat.—Lake Erie to Iowa and Arkansas.

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*ERICYMBA Cope.

Ericymba buccata Cope.

Ericymba buccata Jordan, **D**. 27 (314); **M**. 62.

Habitat.—Michigan to Kansas.

66. *Hybopsis watauga* Jordan and Evermann.

Hybopsis dissimilis Jordan and Gilbert, Proc. U. S. Nat. Mus., 1886,4, Eureka Springs. (Nearly all these specimens belong to *H. Wautauga*).

Hybopsis watauga Jordan, Proc. U. S. Nat. Mus., 1888, 355. (Description).

Habitat.—North Carolina, Indiana, Iowa and Arkansas.

67. *Hybopsis aestivalis* (Girard.)

Hybopsis aestivalis Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 14, Fulton. Jordan, **D.** 29 (340).

Habitat.—Arkansas.

68. *Hybopsis storerianus* (Kirtland.)

Gobio vernalis Girard, **A.** 249 (No. 5, 54), Arkansas River near Ft. Smith; Girard, **B.** 1856, 189, Arkansas River near Ft. Smith.

Hybopsis storerianus Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 14, Fulton. Jordan, **D.** 28 (330); **M.** 65. Meek, **P.** Arkansas River at Mulberry.

Habitat.—Ohio to Nebraska, Tennessee and Arkansas.

69. *Hybopsis kentuckiensis* (Rafinesque).

Hybopsis kentuckiensis Jordan and Gilbert, **C.** 4; Eureka Springs. Meek **O.** Spring River; Myatt and English Creeks at Mammoth Spring; Meek, **P.** Big Spring and Lafferty Creek at Batesville; Jordan's Creek at Dutch Mills; Illinois River at Prairie Grove and Ladd's Mill.

Habitat.—Pennsylvania to Dakota, Arkansas and Alabama. This is the most abundant and widely distributed species in the genus; it reaches a length of ten inches.

27. PHOXINUS Agassiz.

70. *Phoxinus neogæus* Cope.

Phoxinus neogæus Jordan and Gilbert, **C.** 4; Eureka Springs. Jordan, **D.** 31 (402); **M.** 68.

Habitat.—Michigan to Wisconsin and Arkansas.

Only a few specimens of this species have been found.

28. OPSOPŒODUS Hay.

71. *Opsopœodus emiliæ* Hay.

Opsopœodus emiliæ Jordan, **D.** 33 (415); **M.** 68.

Habitat.—Northern Ohio to Southern Indiana, Arkansas and Mississippi.

This is an insignificant and scarce fish.

29. SEMOTILUS Rafinesque.

72. *Semotilus atromaculatus* (Mitchill.)

Leucosomus pallidus Girard, **A.** 256, Antelope Creek, Arkansas; Girard, **B.** 1865, 190, Antelope Creek.

Semotilus atromaculatus Jordan, **D.** 29 (347); **M.** 66. Meek, **O.** 134, Myatt Creek and Spring Branch at Mammoth Spring; 136, Judsonia; 138 Caddo River; Meek, **P.** Polk Bayou, Lafferty and Spring Creeks and Big Spring near Batesville; Flat and Machine Creeks at Smithville; Kings River at Marble; Walnut at Swain; Big Buffalo at Loafer's Glory; Illinois Bayou at Russellville; Illinois River at Prairie Grove.

Habitat.—Massachusetts to Dakota, Virginia and Louisiana.

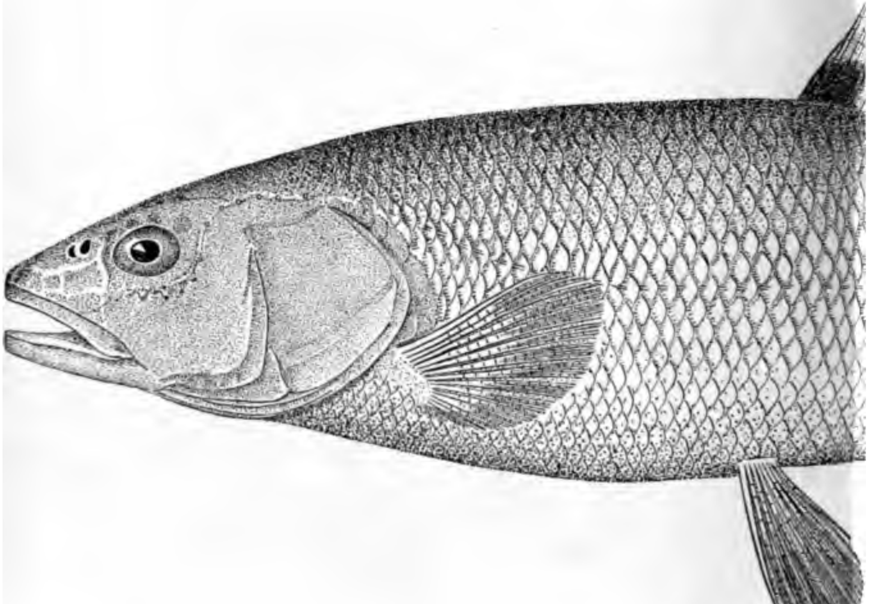
This is one of the largest of the *Cyprinidæ* found in the Mississippi Valley; it reaches a length of over twelve inches.

30. NOTEMIGONUS Rafinesque.

73. *Notemigonus chrysoleucus* (Mitchill). Golden shiner; bream.

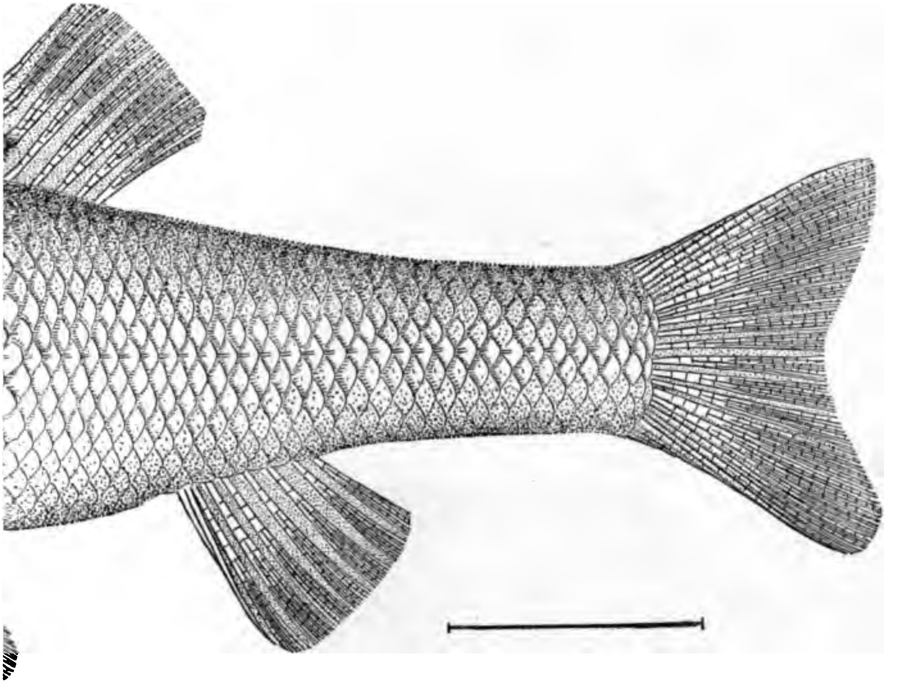
Notemigonus chrysoleucus Jordan, **D.** 33; **M.** 68; Meek, **O.** 128, Spadra Creek at Clarksville; Meek, **P.** Polk Bayou, Spring Creek, Big Spring, Salado and Caney Creeks near Batesville; Little Red River at Judsonia; Bull Creek at Beebe.

Habitat.—Maine to Dakota and Alabama.

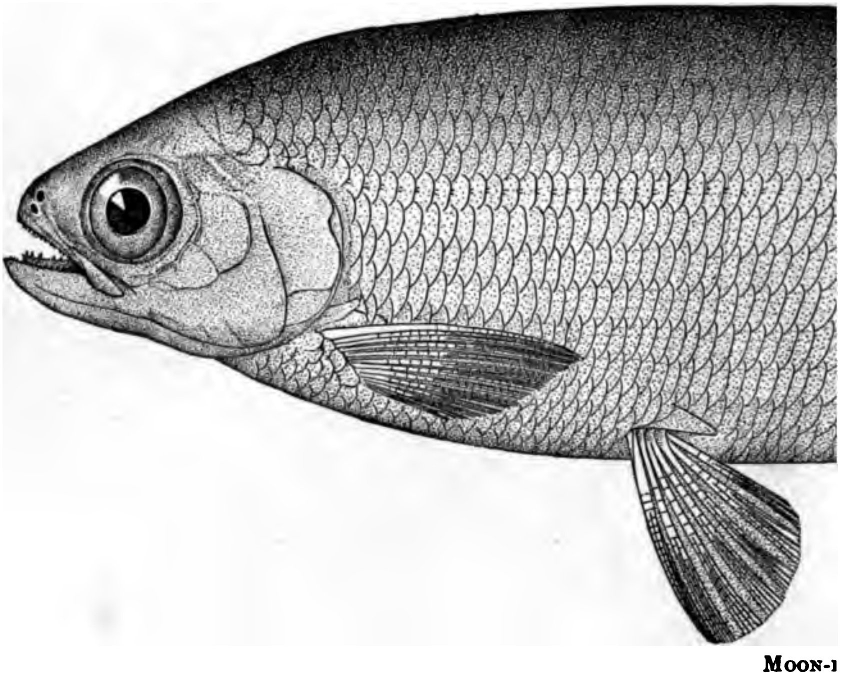


Tʜᴇ (
Semotilus atromaculatus

PLATE V.



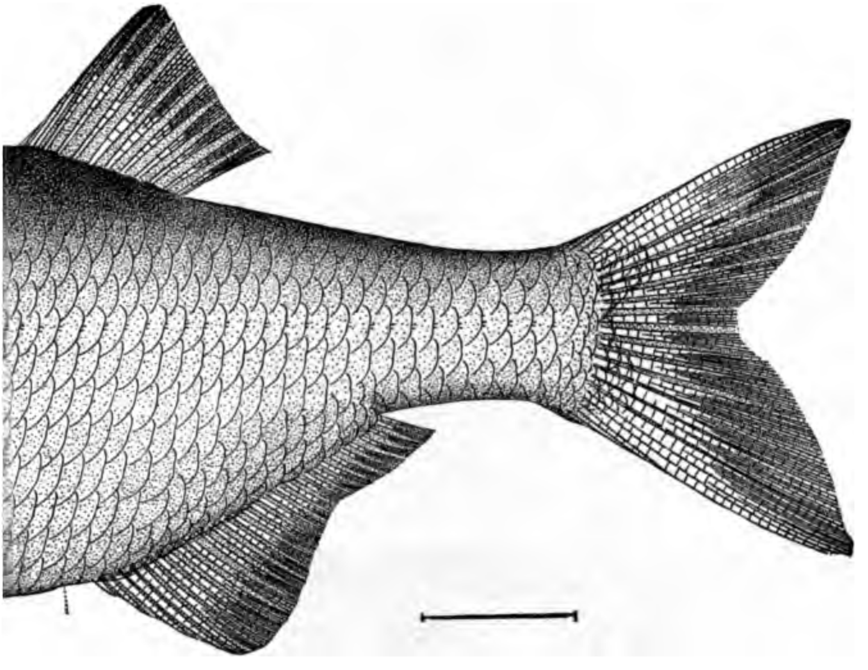
CHUB.
s (Mitchill.) (Page 250.)



Moon-1

Hiodon tergisus

PLATE VI.



SILVER BASS.
Sueur. (Page 251.)

This species inhabits sluggish water, being more common in bayous than elsewhere. Length twelve inches.

FAMILY 9. CHARACINIDÆ.

31. TETRAGONOPTERUS Cuvier.

74. *Tetragonopterus argentatus* Baird and Girard.

Tetragonopterus argentatus Jordan, **D**. 34 (425). Jordan and Gilbert, Synopsis of Fishes, U. S. 1882, 255. (Description).

Habitat.—Arkansas to Mexico.

This is the only representative of this large family in North America. The family belongs to South America and Africa.

FAMILY 10. SALMONIDÆ.

32. SALMO (Artedi) Linnæus.

75. *Salmo irideus* Gibbons. Rainbow trout.

Salmo irideus Jordan, **D**. 44 (524b). Meek, **O**. 134, Spring River, below the dam, escaped from the hatchery at Mammoth Spring.

ORDER 6. ISOSPONDYLI

FAMILY 11. HIODONTIDÆ. (The moon-eyes.)

33. HIODON Le Sueur.

76. *Hiodon alosoides* (Rafinesque).

Hiodon alosoides Jordan and Gilbert, **C**. 14, Fulton. Jordan, **D**. 34 (430); **M**. 69. Meek, **P**. Arkansas River at Little Rock.

Habitat.—Ohio Valley to Arkansas and northward.

This species reaches a length of twelve inches. It has but little value as a food fish.

77. *Hiodon tergisus* Le Seuer. Moon-eye; silver bass; toothed herring.

Hiodon tergisus Jordan and Gilbert, **C**. 11, Arkadelphia and Benton. Jordan, **D**. 24 (431); **M**. 69.

Habitat.—Mississippi Valley and the Great Lakes.

This species inhabits large lakes and rivers; it is seldom taken from small streams. It will take the fly but is not considered a game fish. "Dr. Estes considers it one of the smallest of fishes. They will come up, taste a fly, let go and be gone before the angler has time to strike. Therefore, to be a moon-eye fly fisher, one must be very sharp and not read a book while casting."—Jordan.

The moon-eye feeds upon insects, small fishes and crustaceans; it is full of small bones and is a very poor food fish; it is very handsome, however, and sells readily to its strangers, but is rejected by its acquaintances.

FAMILY 12. **CLUPEIDÆ.** (The herrings.)

34. CLUPEA (Artedi) Linnæus.

78. *Clupea chrysochloris* Rafinesque. Skip-jack.

Clupea chrysochloris Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 11, Arkadelphia and Benton; **C.** 14, Fulton. Jordan, **D.** 36 (442); **M.** 73. Meek, **P.** White River at Batesville; Mulberry River at Mulberry; Little Red River at Judsonia.

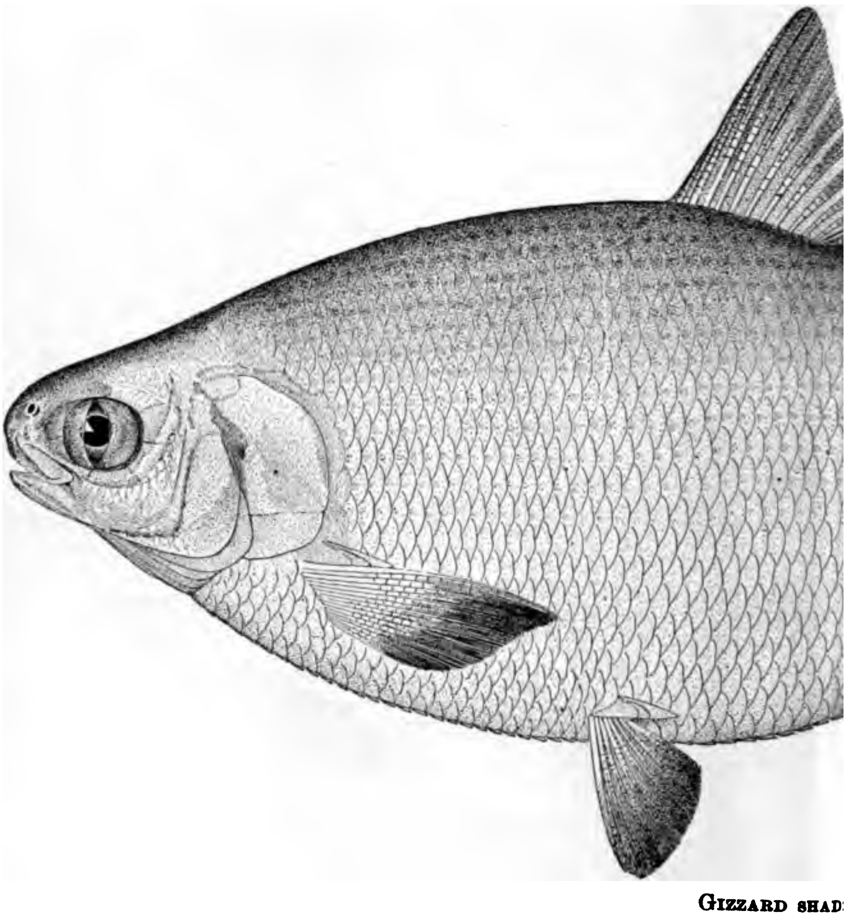
Habitat.--Mississippi Valley. It has been itroduced into the Great Lakes.

Fish of this species feed upon small fishes, crustaceans and insects. They usually run in schools and in the evening are often seen jumping out of the water. They reach a length of eighteen inches, but as a food fish they are nearly worthless.

35. DOROSOMA Rafinesque.

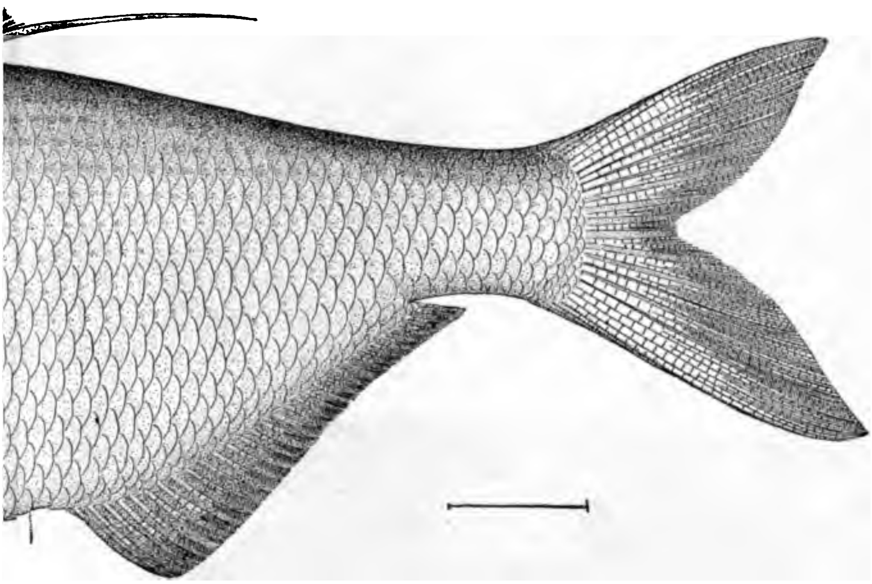
79. *Dorosowa ccpedianum* Le Sueur). Gizzard shad; hickory shad.

Dorosoma ccpedianum Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 11, Arkadelphia and Benton; **C.** 11, Fulton. Jordan, **D.** 37 (455); **M.** 74. Meek, **O.** 128, Spadra Creek at Clarksville; Meek, **P.** White River at Batesville; Little Red River at Heber and Judsonia; Black



Gizzard shad

Dorosoma cepedianum (L



HICKORY SHAD.

› Sueur.) Page 252.)

River at Black Rock; East Fork of the Cadron north of Conway; Arkansas River at Mulberry; Bull Creek at Beebe.

Habitat—Cape Cod to Mexico.

It is a handsome mud-loving fish. It reaches a length of about fifteen inches, but is nearly worthless for food.*

FAMILY 13. CYPRINODONTIDÆ.

36. FUNDULUS Lacépède.

80. *Fundulus catenatus* (Storer). Stud-fish.

Fundulus catenatus Jordan and Gilbert, **C.** 5, Eureka Springs; **C.** 12, Arkadelphia and Benton. Jordan, **D.** 49 (569); **M.** 85. Meek, **O.** 134, Myatt Creek at Mammoth Spring; 138, Ouachita and Saline Rivers; Meek, **P.** White River, Polk Bayou and Lafferty Creek near Batesville; King's River at Marble; Big Buffalo at Loafer's Glory; Spring River at Black Rock; Middle and Main Forks of White River near Fayetteville; Flat and Machine Creeks at Smithville.

Habitat.—Mountain streams of East Tennessee and the Ozark region.

A handsome fish; length seven inches.

81. *Fundulus zebrinus* Jordan and Gilbert.

Fundulus zebrinus Jordan, **D.** 48 (560); **M.** 86.

Habitat.—Iowa, Kansas to Texas.

Smaller and less brightly colored than the preceding.

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*FAMILY AMBLYOPSIDÆ.

TYPHLICHTHYS Girard.

Typhlichthys subterraneous Girard.

Typhlichthys subterraneous Girard. **D.** 47 (540); **M.** 83.

Habitat.—Cave streams of Kentucky, Tennessee, Alabama and Missouri.

37. ZYGONECTES Agassiz.*

82. *Zygonectes notatus* (Rafinesque). Top minnow.

Zygonectes notatus Jordan and Gilbert, **C.** 5, Eureka Springs; **C.** 8, Ft. Smith; **C.** 12, Arkadelphia and Benton; **C.** 14, Fulton. Jordan, **D.** 49 (576); **M.** 86. Gilbert, **E.** 609, Western Arkansas. Meek, **O.** 128, Spadra Creek at Clarksville; 134, Spring River, Myatt and English Creeks at Mammoth Spring; 136, Judsonia; 138, South Fork Ouachita, and Saline and Caddo Rivers; Meek, **P.** White River, Spring, Salado, Caney and Lafferty Creeks and Polk Bayou near Batesville; Little Red River at Heber; Middle Fork of Little Red River at Kinderhook; Devil's Fork of Little Red River at Shiloh; Strawberry River, Flat and Machine Creeks at Smithville; Illinois River at Prairie Grove and Ladd's Mill; Mulberry River at Mulberry; Village Creek at Newport; Cadron Creek north of Conway; Cove Creek at Martinsville; Illinois Bayou at Russellville; Black and Spring Rivers at Black Rock.

Habitat.—Michigan to Alabama and Texas.

This species seldom exceeds three inches in length. It lives among the weeds and is a surface swimmer.

38. GAMBUSIA Poey.

83. *Gambusia patruelis* (Baird and Gilbert). Top minnow.

Gambusia patruelis Jordan and Gilbert, **C.** 8, Ft. Smith; **C.** 11, Arkadelphia; **C.** 14 Fulton.

**Zygonectes macdonaldi* Meek.

Zygonectes macdonaldi Meek, **O.**

Habitat.—Southern Missouri.

So far this species is known only from southwest Missouri. It is probably a member of the Arkansas fauna. *Z. sciadicus* Cope, is a closely related species if it does not prove to be the same. If the two are identical, the latter will be the proper name.

Jordan, **D.** 50 (585); **M.** 87. Meek, **P.** Spring Creek, Big Spring and Polk Bayou at Batesville; Strawberry River at Smithville; Black and Spring Rivers at Black Rock; Cadron Creek north of Conway.

Habitat.—Potomac to Illinois and the Rio Grande.

This is a small and interesting fish. It seldom reaches a length of three inches, the males being smaller than the females. The anal fin is modified into a sort of intromittent organ, the eggs are fertilized in the body of the female and the young are born about a third of an inch in length. The males are scarce and resemble *Zygonectes*. As such they have been frequently described. This is the only species in Arkansas in which the young are born alive.

Family 14. LUCIIDÆ.

39. Lucius Rafinesque.

84. *Lucius vermiculatus* Le Sueur. Little pickerel.

Lucius vermiculatus Meek, **O.** 134, Myatt Creek and Bayou of Spring River at Mammoth Spring; 138 Mazarn Creek and South Fork of the Ouachita River.

Esox vermiculatus Jordan and Gilbert, **C.** 12, Benton; **D.** 50 (598). **M.** 88. Meek, **P.** Little Red River at Heber and Judsonia; Black River at Black Rock; Spring Creek and Big Spring at Batesville; Bull Creek at Beebe.

Habitat.—Mississippi Valley.

This species is quite common in Arkansas. It lives among the weeds, and seldom reaches a length of fifteen inches; it is carnivorous and a very good food fish except that it is so small.

85. *Lucius reticulatus* Le Sueur. Eastern pickerel.

Esox reticulatus Jordan, **D.** 50 (599); **M.** 89. Meek, **O.** 134, English Creek at Mammoth Spring; 136, Judsonia; Meek, **P.** Little Red River at Heber and Judsonia.

Habitat.—Maine to Arkansas. Coastwise and mountain streams.

This species until recently was supposed to inhabit only the coastwise streams of the Alleghany region. It is quite common, however, in the Ozark region. This one species of the genus seems to be confined to the mountains. It reaches a length of thirty inches; it is a swift swimmer and very voraceous, seeming to be able to swallow the sun-fish or other spiny-rayed fish with as much ease as it does the softest of minnows or suckers.

"It delights to loiter in the shelter of the pads of the pond lilly and in the shadows of the dense masses of Potamogeton, a few inches below the surface of the water. Motionless, in such situations, it awaits the coming of the unwary minnow, quicker than thought, it darts upon its prey and while you look, sinks slowly from sight. There is no apparent motion of fin or tail, but ere you realize it the ravenous beauty is gone." —Call.

The game qualities of this fish are excelled only by those of the black bass. As a food fish it has few if any superiors in our fresh waters. Of the five species of this genus this one is fondest of the cool clear mountain streams.

FAMILY 15. ANGUILLIDÆ.

40. ANGUILLA Thunburg.

86. *Anguilla anguilla chrysypa* Rafinesque. The common eel.

Anguilla anguilla rostrata Jordan, **D.** 55 (638); **M.** 90. Meek, **P.** Black River at Black Rock; Middle Fork or Little Red River at Kinderhook.

Habitat.—Mississippi Valley.

This is an excellent food fish.

FAMILY 16. ATHERINIDÆ.

41. LABIDESTHES Cope.

87. *Labidesthes sicculus* Cope. Brook silver-side; skip-jack.

Labidesthes sicculus Jordan and Gilbert, **C.** 5, Eureka Springs; **C.** 8, Ft. Smith; **C.** 12, Arkadelphia and Benton. Meek, **O.** 128, Spadra Creek at Clarksville; 135, Myatt Creek at Mammoth Springs; 136, Judsonia; 139, Ouachita, Caddo and Saline Rivers; Meek, **P.** Little Red River at Heber; Middle Fork of Little Red River at Kinderhook; Village Creek at Newport; Salado and Caney Creeks and Polk Bayou near Batesville; Devil's Fork of Little Red River at Shiloh; Strawberry River at Smithville; Illinois Bayou near Russellville; Illinois River at Prairie Grove and Ladd's Mill; Mulberry River at Mulberry; King's River at Marble; Big Buffalo at Loafer's Glory; Spring and Black Rivers at Black Rock; Main Fork of White River at Fayetteville.

Habitat.—Michigan to Perdido Bay, Kansas and Arkansas. This species is very slender and seldom reaches a length of : inches. It is very abundant in quiet waters, feeding upon ects, their larva, and on small crustaceans.

FAMILY 17. **APHREDODERIDÆ.** (The pirate perches.)

42. APHREDODERUS Le Sueur.

Aphredoderus sayanus (Gilliams). Pirate perch.

Aphredoderus sayanus Jordan, Syn. Fishes N. A. Jordan, **D.** 76 (838); **M.** 113. Meek, **O.** 136, Judsonia; 139, Caddo Gap; Meek, **P.** Spring Creek and Big Spring at Batesville; Black River at Black Rock.

Asternotremia mesotrema Jordan, Bull, U. S. Nat. Mus. 1877, 52, Little Red River at Judsonia.

Habitat.—New York to Louisiana and north to Minnesota.

FAMILY 18. ELASSOMATIDÆ.

43. ELASSOMA Jordan.

89. *Elassoma zonatum* Jordan.

Elassoma zonatum Jordan, Bull. U. S. Nat. Mus. 59. Little Red River, Arkansas. Jordan, **D.** 76 (839); **M.** 113. Meek, **O.** 136, Judsonia. Meek, **P.** Spring Creek at Batesville.

Habitat.—Southern Illinois to Arkansas and Louisiana.

But little is known concerning this species. It resembles the sun-fishes and, like them, lives in grassy brooks.

FAMILY 19. CENTRARCHIDÆ. (The sun-fishes.)

44. CENTRARCHUS (Cuv. and Val.).

90. *Centrarchus macropterus* Lacépède.

Centrarchus macropterus Jordan, 77, (841); **M.** 114. Meek, **P.** Bull Creek at Beebe.

Habitat.—North Carolina to Southern Illinois and south.

45. POMOXIS Rafinesque.

91. *Pomoxis sparoides* (Lacépède). Calico bass; grass bass; bar-fish; strawberry bass.

Pomoxis sparoides Jordan and Gilbert, **C.** 14. Fulton. Jordan, **D.** 76 (843); **M.** 115. Meek, **P.** Black River at Black Rock; East Fork of Cadron Creek north of Conway; Little Red River at Judsonia.

Habitat.—New Jersey to Louisiana and Minnesota.

This species lives in weedy places. It feeds upon insects, crustaceans and fishes, and seldom reaches a length of twelve inches. It is an excellent pan-fish, and is usually sold in the markets with the next species under the name of "crappie." It is more abundant north than the next.

92. *Pomoxis annularis* Rafinesque. Crappie; batchelor.

Pomoxis annularis Jordan and Gilbert, **C.** 10, Ft. Smith. Jordan, **D.** 76; **M.** 115.

Habitat.—Mississippi Valley.

This species much resembles the preceding. It is more common south.

46. AMBLOPLITES Rafinesque.

93. *Ambloplites rupestris* (Rafinesque). Rock bass; red-eye; goggle-eye.

Ambloplites rupestris Jordan, **D.** 76 (845); **M.** 115. Meek, **O.** 135, Spring River and English Creek at Mammoth Spring; 139, Ouachita and South Fork of the Ouachita. Black River at Black Rock; Devil's and Middle Forks of Little Red River at Kinderhook; White River at Johnson.

Habitat.—Vermont to Manitoba, Louisiana and North Carolina, more abundant west.

This species prefers grassy streams and ponds, although it is frequently taken from the river currents. Its food consists of insects, crustaceans and fishes. It reaches a length of twelve inches and is an excellent game fish.

47. CHÆNOBRYTTUS Gill.

94. *Chænobryttus gulosus* (Cuv. and Val.). War-mouth; red-eyed bream.

Chænobryttus gulosus Jordan, **D.** 76 (846); **M.** 115. Meek, **O.** 136, Myatt Creek at Mammoth Spring; 137, Judsonia; 139, Caddo Gap; Meek, **P.** Bull Creek at Beebe; Cove Creek at Martinsville.

Habitat.—Michigan to Virginia and Texas.

This species resembles the rock bass somewhat. It reaches a length of about twelve inches. It is chiefly piscivcrous, is a very good food fish, lives in weed ponds and is more abundant south than north.

48. LEPOMIS Rafinesque.

This is a large genus and one of the most difficult in which to distinguish species. Most of the species are subject to more or less individual variations; some of them are highly colored. The operculum usually terminates in a membrane, or lap. This varies in length with age, being largest in adult

individuals. To this genus belong most of our smallest sun-fishes. Very few are large enough for food.

95. *Lepomis cyanellus* (Rafinesque). Green sun-fish.

Calliurus formosus Girard, **A.** 14, Ft. Smith; Ft. Washita, Red River; Girard, **B.** 1857, 200.

Calliurus longulus Girard, **A.** 16, Otter Creek.

Calliurus microps Girard, **A.** 17, Ft. Washita.

Lepomis cyanellus Jordan and Gilbert, **C.** 10, Ft. Smith; **C.** 12, Arkadelphia and Benton. Jordan, **D.** 77 (853); **M.** 117. Meek, **O.** 135, Spring River, English and Myatt Creeks at Mammoth Spring; 136, Judsonia; 139, Caddo and Ouachita Rivers; Meek, **P.** White River, Spring Creek, Big Spring and Lafferty Creek near Batesville; Strawberry River, Flat and Machine Creeks at Smithville; Mulberry River at Mulberry; Illinois River at Ladd's Mill and Prairie Grove; King's River at Marble; Big Buffalo at Loafer's Glory; North Fork of Cadron Creek north of Conway; Middle Fork of Little Red River at Kinderhook; Black River at Black Rock,

Habitat.—Great Lakes to Georgia and Mexico.

This is one of the most abundant of the sun-fishes. It reaches a length of of about seven inches; though small it often finds its way to the table with other edible sun-fishes.

96. *Lepomis macrochirus* Rafinesque.

Lepomis macrochirus et ischyrus Jordan, **D.** 77 (856-7); **M.** 117.

Lepomis macrochirus Meek **P.** White River and Big Spring at Batesville; Little Red River at Shiloh.

Habitat.—Ohio to Arkansas and Iowa.

97. *Lepomis megalotis* Rafinesque. Long-eared sun-fish.

Pomotis aquilensis Girard, **A.** 25. Sugar Loaf Creek. (Misidentified by Girard.)

Pomotis breviceps Girard, **A.** 28, Otter Creek; Ft. Smith; Ft. Washita.

Lepomis megalotis Jordan, **M.** 118. **A.** 117 (864). Jordan and Gilbert, **C.** 12, Arkadelphia and Benton. Gilbert, **E.** 609, Waldron. Meek, **O.** 128, Spadra Creek at Clarksville; 135, Spring River, English and Myatt Creeks at Mammoth Springs; 139, Ouachita Caddo and Saline Rivers; Flat and Machine Creeks at Smithville; Little Red River at Heber; Middle and South Forks of Little Red River at Kinderhook; White River, Salado and Caney Creeks at Batesville; Jordan's Creek at Dutch Mills; Mulberry Creek at Mulberry; Main and Middle Forks of White River near Fayetteville; Walnut Fork of Piney at Swain; Big Buffalo at Loafer's Glory; Black and Spring Rivers at Black Rock; Bull Creek at Beebe; East Fork of Cadron, and Cove Creek near Conway; Devil's Fork of Little Red River at Shiloh Little Red River at Judsonia; Illinois Bayou at Russellville.

Habitat.—Michigan to Dakota, South Carolina and Mexico.

This is a very variable and common species. It reaches a length of six inches, being too small for a food fish.

98. *Lepomis garmani* Forbes.

Lepomis garmani Jordan, **D.** 77 (865); **M.** 119. Meek, **O.** 135, Spring River at Mammoth Spring; Meek, **P.** Salado, Caney and Spring Creeks at Batesville; Black River at Black Rock.

Habitat.—Wabash valley to Arkansas.

It is a small and highly colored sun-fish.

99. *Lepomis pallidus* (Mitchill). Blue sun-fish.

Lepomis pallidus Jordan and Gilbert, **C.** 10, Ft. Smith; **C.** 12, Arkadelphia and Benton; **C.**

14, Fulton. Meek, **O**. 135, Spring River, English and Myatt Creeks at Mammoth Spring; 139, Caddo River at Caddo Gap Little Red River at Heber; Black and Spring Rivers at Black Rock; Bull Creek at Beebe; East Fork of Cadron near Conway; Cove Creek at Martinsville; Little Red River at Shiloh; Little Red River at Judsonia Illinois Bayou at Russellville.

Habitat.—Great Lakes to New York, Florida, Mexico and Dakota.

This species reaches the length of about ten inches. It is very common wherever it occurs and may always be found in markets with crappies and other pan-fishes.

100. *Lepomis humilis* (Girard).

Bryttus humilis Girard, **A**. 21, Sugar Loaf Creek; Girard, **B**. 1857, 201.

Lepomis humilis Jordan and Gilbert, **C**. 12, Eureka Springs, Arkadelphia and Benton; **C**. 10, Ft. Smith. Jordan, **D**. 77 (868); **M**. 118. Gilbert, **E**. Waldron. Meek, **O**. 128, Spadra Creek at Clarksville; Mulberry Creek at Ladd's Mill; Illinois Bayou at Russellville.

Habitat.—Kentucky to Nebraska and Texas.

A small and highly colored species; very abundant wherever found.

101. *Lepomis albulus* (Girard).

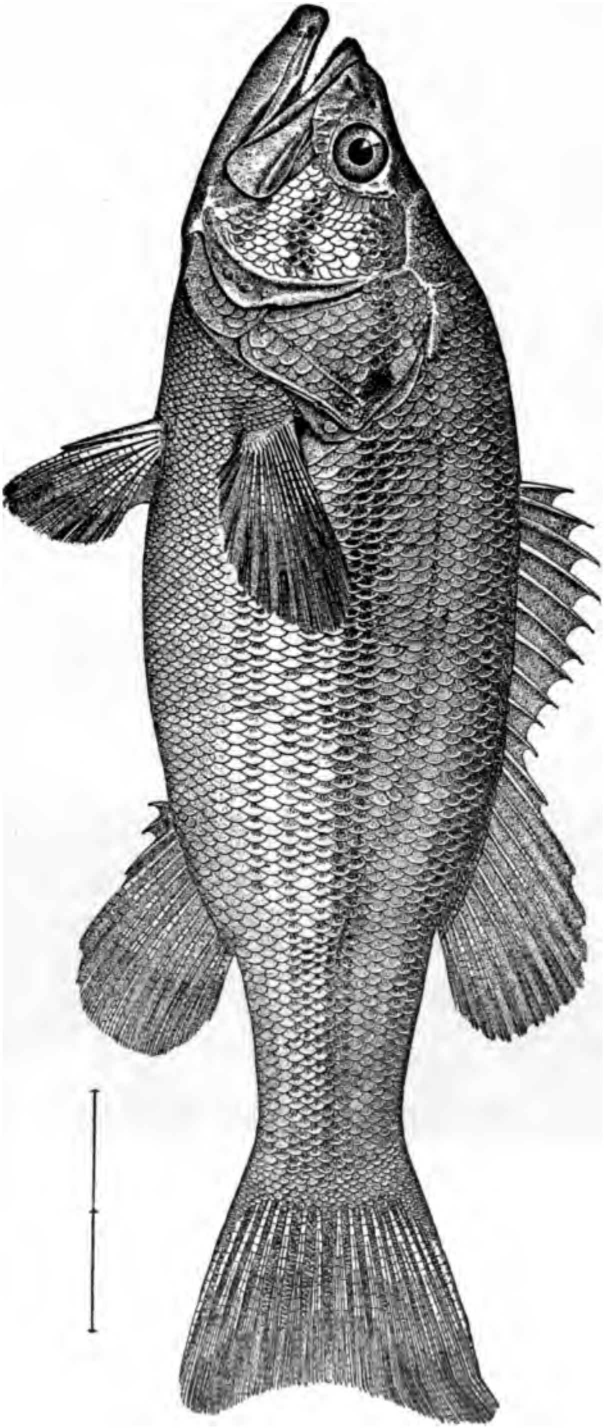
Lepomis albulus Jordan, **D**. 77 (872). Jordan and Gilbert, Syn. Fishes N. A. 1882, 479. (Description.)

Habitat.—Florida to Texas.

49. MICROPTERUS Lacépède.

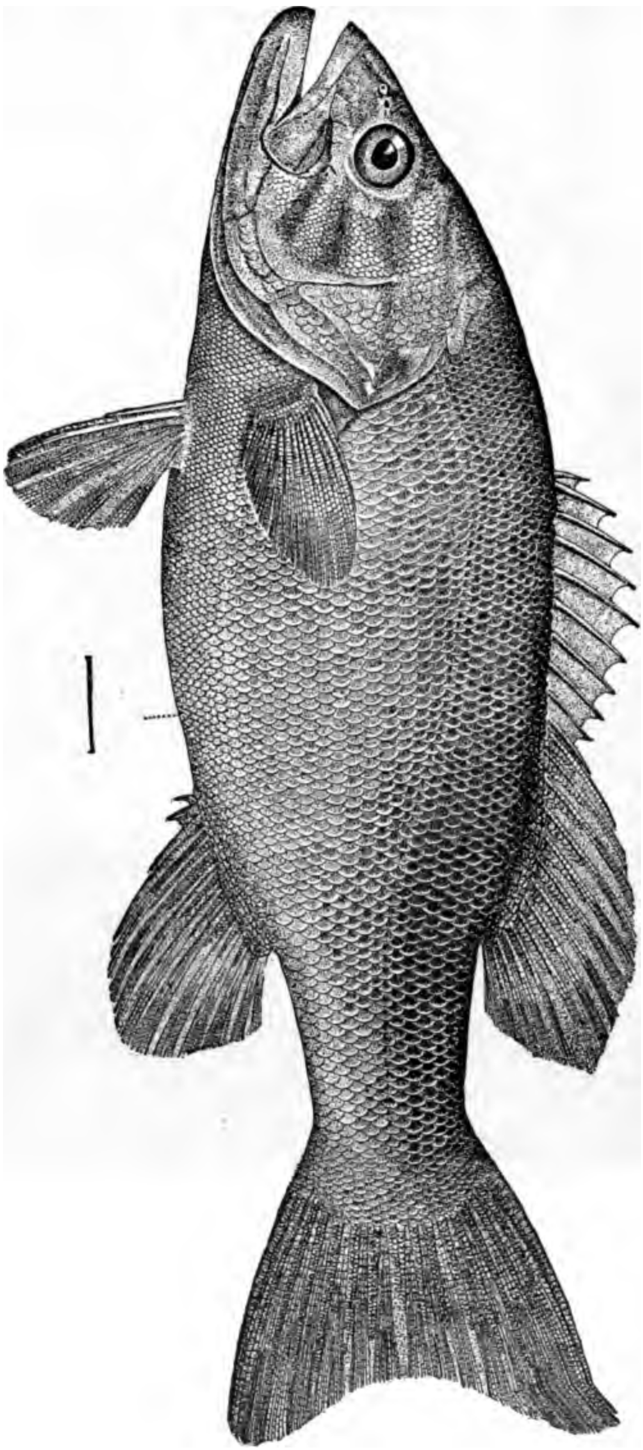
102. *Micropterus salmoides* (Lacépède). Large mouthed black bass.

Dioplites nuecencis Girard, **A**. Coal Creek.



LARGE MOUTHED BLACK BASS.
Micropterus salmoides (Lacépède.) Page 262.)

PLATE X.



SMALL MOUTHED BLACK BASS.
Micropterus dolomieu Lacépède. (Page 263.)

Micropterus salmoides Jordan and Gilbert, **C.** 10, Ft. Smith; 12, Arkadelphia and Benton; 14, Fulton. Jordan, **D.** 77; **M.** 120. Meek, **O.** 135, Spring River, English and Myatt Creeks at Mammoth Spring; 139, Ouachita and Caddo Rivers; **P.** White River, Salado and Caney Creeks and Polk Bayou at Batesville; Village Creek at Newport; Strawberry River at Smithville; Black and Spring Rivers at Black Rock; Bull Creek at Beebe; East and North Forks of the Cadron, and Cove Creek near Conway; Arkansas and Mulberry Rivers at Mulberry; Illinois Bayou at Russellville; Main Fork of the White River near Fayetteville; Little Red River at Judsonia.

Habitat.—Dakota to New York, Florida and Mexico.

The large-mouthed black bass is more widely distributed than the small-mouthed one; it also prefers sloughs, ponds and still waters. It is an excellent food fish, and is also highly prized as a game fish. Its habits are about the same as those of the next species which is its only superior.*

The black bass is very ravenous. It feeds upon the spiny as well as the soft rayed fishes. The writer once took half a pound of sun-fish from the stomach of a black bass weighing six pounds. The sun-fishes were in the stomach side by side, some taken in head and others tail foremost.

103. *Micropterus dolomieu* Lacépède. Small-mouthed black bass.

Micropterus dolomieu Jordan and Gilbert, **C.** Eureka Springs; **C.** 12, Arkadelphia. Jordan, **D.** 77 (877); **M.** 120. Meek, **O.** 135, Spring River at Mammoth Spring; 139, Ouachita and Saline Rivers; **P.** White River and Lafferty Creek at Batesville; Strawberry

*For a full discussion of the black bass, see the excellent "Book of the Black Bass," by Dr. Henshall; Robert Clarke & Co., Cincinnati, Ohio.

River at Smithville; South, Middle and Devil's Fork of the Little Red River at Kinderhook; Little Red River at Heber; Middle and Main Forks of White River at Fayetteville; Illinois River at Prairie Grove and Ladd's Mill; Jordan's Creek at Dutch Mills; Mulberry River at Mulberry; Illinois Bayou at Russellville.

Habitat.—St. Lawrence River to Dakota, Arkansas, Alabama and South Carolina.

The species prefers clear cool water. Both as a game and food fish it is regarded as superior to the preceding. The following is quoted from Dr. Henshall's "Book of the Black Bass":

"The Black Bass is eminently an American fish, and has been said to be representative in his characteristics. He has the faculty of asserting himself and making himself completely at at home wherever placed. He is plucky, game, brave and unyielding to the last when hooked. He has the arrow rush and vigor of a Trout, the untiring strength and bold leap of a Salmon, while he has a system of fighting tactics peculiarly his own. He will rise to the artificial fly as readily as the Salmon or the Brook Trout, under the same conditions; and will take the live Minnow or other live bait, under any and all circumstances favorable to the taking of any other fish. I consider him inch for inch and pound for pound, the gamest fish that swims. The royal Salmon and the lordly Trout must yield the palm to a Black Bass of equal weight. That he will eventually become the leading game fish of American is my oft expressed opinion and firm belief. Black Bass are very prolific, the females yielding fully one-fourth of their weight in spawn. The period of spawning extends from early spring to midsummer, according to the section of country and temperature of water, being always earlier in warm or shallow waters.

"The Bass leave their winter quarters in deep water about a month or six weeks before the spawning season, at which times they can be seen running up streams and in the shallow

portions of lakes in great numbers. Soon afterwards the males and females pair off and prepare for breeding. They select suitable spots for their nests, usually upon a gravelly or sandy bottom, or in rocky ledges, in water from eighteen inches to three feet deep in rivers, and from three to six feet deep in coves and ponds; and, if possible, adjacent to deep water or patches of aquatic plants, to which the parent fish retire if disturbed.

"The nests are circular, saucer-like depressions, about twice the length of the fish in diameter. They are formed by the Bass, by fanning and scouring from the pebbles all sand and vegetable debris, by means of their fins and tails, and by removing larger obstacles with their mouths. This gives to the beds a bright, clean, and white appearance, which in clear water can be seen at a distance of several score yards. I have seen hundreds of such nests in groups, almost touching each other, in the clear water lakes of Wisconsin, Michigan and Minnesota.

"Sometimes the nests are formed upon a muddy bottom, with a pavement or foundation of small sticks or leaves, from which the mud and slime have been washed and scoured.

"The females deposit their eggs on the bottom of the nests, usually in rows, which are fecundated by the male, and become glued to the pebbles and sticks contained therein. The eggs are hatched in from one to two weeks, depending on the temperature of the water, but usually in ten days.

"After hatching, the young fry remain over the bed for three or four days, when they retire into deep water, or take refuge in the weeds or under stones, logs and other hiding places.

"During the period of incubation the nests are carefully guarded by the parent fish, who remain over them, and by a constant motion of the fins create a current, which keeps the eggs free from any sediment or debris. After the eggs are hatched, and while the young remain on the nests, the vigilance of the parent fish becomes increased and unceasing, and all suspicious and predatory intruders are driven away.

"Their anxiety and solicitude for their eggs and young, and their apparent disregard of their own safety at the time, is well known to poachers and pot fishers, who take advantage of this trait, and spear or gig them on their nests.

"I have also known some, who call themselves anglers, who take the bass at this time in large numbers, with the Minnow or craw-fish. Of course, the Bass does not 'bite' at this season voluntarily, but when the bait is persistently held under their noses, they at first endeavor to drive it away or remove it from their nests, and finally, I think, swallow it in sheer desperation.

"After the young Bass leave the spawning beds, their food at first consists of animalculæ, larvæ, insects, and the ova of other fish; as they grow older and larger, they devour worms, tad-poles and small fish, and later in life, they vary their diet with craw-fish, frogs, mussels and water snakes, until, attaining a weight of two pounds, they will bolt anything, from an angle-worm to a young musk-rat."

FAMILY 20. PERCIDÆ. (The perches.)

50. ETHEOSTOMA Rafinesque.

To this genus belongs a large group of small fresh-water fishes. They can easily be distinguished from the minnows which they resemble in form, by the presence of two dorsal fins, the high coloration and the small ctenoid scales. They are solid and firm while the minnows have cycloid scales and are very soft.

The genus contains a large number of species, the largest scarcely eight inches in length, while the average size is about two and a half inches.

They are active and beautiful, and inhabit clear, swift and rocky streams. They always keep close to the bottom, hiding under stones. They are more numerous where the rocks are covered with vegetation.

The darters are difficult to capture. They lie close to the bottom, hide under stones or bury themselves in the sand, allowing the lead line of the net to pass over them. In captur-

ing them it is best to use a small seine, heavily leaded. Rapid hauls must be made in shallow water with rocky or gravelly bottom. To collect darters requires some skill and practice. The darters are called by Prof. Forbes the "mountaineers among fishes." "Forced from the populous and fertile valleys of the river beds and lake bottoms, they have taken refuge from their enemies in the rocky highlands, where the free waters play in ceaseless torrents, and there they have wrested from stubborn nature a meager living."

Although diminished in size by their continual struggle with the elements they have developed an activity and hardihood, a vigor of life and a glow of high color, almost unknown among the easier livers of the lowlands. They are not so much dwarfed as concentrated fishes.—Forbes.*

The food of the darter consists mostly of insects, larvae and small crustaceans.

104. *Etheostoma pellucidum vivax* (Hay).

Ammocrypta vivax Jordan and Gilbert, **C.** 12, Arkadelphia and Benton; 9. Ft. Smith. Jordan, **D.** 77 (880). Jordan and Gilbert, Syn. Fish. N. A. 1882, 970. (Description.)

Habitat.—Mississippi and Arkansas.

104a. *Etheostoma pellucidum clarum* Jordan and Meek.

Ammocrypta clara Jordan and Gilbert, **C.** 14, Fulton. Jordan, **D.** 77 (879).

Etheostoma pellucidum clarum Jordan, **M.** 123. Meek, **P.** White River and Polk Bayou at Batesville; Strawberry River at Smithville; Little Red River at Judsonia; Illinois Bayou at Russellville.

Habitat.—Indiana to Iowa and Arkansas.

This and the preceding darter is nearly white and lies on the bottom nearly buried in the sand.

105. *Etheostoma asprellus* (Jordan).

*For an excellent account of the darters see "Science Sketches" by Dr. D. S. Jordan. A. C. McClurg & Co., Chicago, Ill.

Crystellaria asprellum Jordan and Gilbert, **C.** 12, Arkadelphia. Jordan, **D.** 78 (882).

Etheostoma asprellus Jordan, **M.** 123.

Habitat.—Southern Indiana to Illinois, Alabama and Arkansas.

106. *Etheostoma nigrum* Rafinesque. "Johnny."

Etheostoma olmstedi ozarkanum Jordan, **D.** 78 (885).

Etheostoma nigrum Jordan, **M.** 124. Meek, **O.** Caddo River at Caddo Gap; **P.** Black River at Black Rock; Polk Bayou, Salado and Caney Creeks at Batesville; Village Creek at Newport; East Fork of Cadron Creek near Conway.

Habitat.—Dakota to western Pennsylvania, Arkansas and Georgia.

107. *Etheostoma chlorosoma* (Hay).

Etheostoma chlorosoma Jordan, **M.** 124. Meek, **O.** 139, Ouachita River.

Habitat.—Mississippi and Arkansas.

108. *Etheostoma histrio* Jordan and Gilbert.

Ulocentra histrio Jordan and Gilbert, **C.** 9, Ft. Smith; **C.** 12, Arkadelphia and Benton. Jordan, **D.** 78 (892).

Etheostoma histrio Gilbert, Proc. U. S. Nat. Mus. 1887, 47. (Description.)

Habitat.—Indiana to Arkansas.

109. *Etheostoma uranidea* Jordan and Gilbert.

Cottogaster uranidea Jordan and Gilbert, **C.** 12, Arkadelphia. Jordan, **D.** 79 (897).

Etheostoma uranidea Gilbert, Proc. U. S. Nat. Mus. 1887, 48. (Description.) Meek, **P.** White River at Oxford Bend and Batesville; Black and Spring Rivers at Black Rock.

Habitat.—Southern Indiana, Missouri and Arkansas.

110. *Etheostoma juliæ* Meek.

Etheostoma juliæ Meek, **P.** King's River at Marble;

White River at Oxford Bend; Middle Fork of White River at Fayetteville.

Habitat.—Ozark region.

111. *Etheostoma shumardi* (Girard).

Cottogaster shumardi Jordan and Gilbert, **C.** 9, Ft. Smith; **C.** 14, Fulton. Jordan **D.** 79 (898).

Etheostoma shumardi Jordan, **M.** 126.

Habitat.—Wabash River to Iowa and Arkansas. Usually found in the larger streams.

112. *Etheostoma blennioides* Rafinesque. Green-sided darter.

Diplesion blennioides Jordan and Gilbert, **C.** 5, Eureka Springs; **C.** 9, Ft. Smith; **C.** 13, Arkadelphia. Jordan, **D.** 78 (894).

Etheostoma blennioides Jordan, **M.** 125. Meek, **O.** 128, Spadra Creek at Clarksville; 135, Spring River, Myatt and English Creeks at Mammoth Spring; 137, Judsonia; 139, Ouachita and Saline Rivers; White River at Batesville; Strawberry River, Flat and Machine Creeks at Smithville; Walnut Fork of Piney at Swain; Big Buffalo at Loafer's Glory; Middle Fork of Little Red River at Kinderhook; Middle Fork of White River near Fayetteville; Illinois River at Ladd's Mill; Illinois Bayou at Russellville; Cove Creek at Martinsville.

Habitat.—Pennsylvania to Alabama and Kansas.

113. *Etheostoma caprodes* Rafinesque.

Etheostoma caprodes Meek, **O.** 128, Spadra Creek at Clarksville; 139, Ouachita River at Bear City; **P.** White River at Batesville; Strawberry River at Smithville; Illinois River at Prairie Grove and Ladd's Mill; Black and Spring Rivers at Black Rock; Little Red River at Heber; Middle and Main Forks of White River near Fayetteville.

Habitat.—Great Lakes to Virginia, Alabama and Texas.

114. *Etheostoma copelandi* (Jordan).

Cottogaster copelandi Jordan and Gilbert, **C**. 9, Ft. Smith; **C**. 12, Arkadelphia and Benton. Jordan, **D**. 78 (895).

Etheostoma copelandi Jordan, **M**. 125. Meek, **O**. 139, Ouachita River near Bear City.

Habitat.—Southern Indiana to Arkansas.

115. *Etheostoma phoxocephalum* Nelson.

Hadropterus phoxocephalus Jordan and Gilbert, Ft. Smith. Jordan, **D**. 79 (901). Meek, **P**. Middle Fork of Little Red River at Kinderhook; Spring River at Black Rock; Strawberry River at Smithville.

Etheostoma phoxocephalum Jordan, **M**. 127. Meek, **O**. 139, Ouachita River at Bear City.

Habitat.—Indiana to Kansas and Arkansas.

116. *Etheostoma aspro* (Cope and Jordan). Black-sided darter.

Hadropterus aspro Jordan and Gilbert, **C**. 9, Ft. Smith; **C**. 19, Fulton. Jordan, **D**. 79 (902).

Etheostoma aspro Jordan, **M**. 127. Meek, **P**. White River, Salado and Caney Creeks near Batesville; Strawberry River at Smithville; Black River at Black Rock; East Fork of Cadron near Conway; Little Red River at Judsonia.

Habitat.—Western Pennsylvania to Dakota and Arkansas.

117. *Etheostoma ouachitæ* (Jordan and Gilbert).

Hadropterus ouachitæ Jordan and Gilbert, **C**. 13, Benton. Jordan, 79 (903).

Etheostoma ouachitæ Gilbert, Proc. U. S. Nat. Mus., 1887, 49.

Habitat.—Southern Indiana and Arkansas.

118. *Etheostoma camurum* (Cope). Blue-breasted darter.

Etheostoma camurum Jordan and Gilbert, **C**. 9, Ft. Smith; **C**. 12, Arkadelphia and Benton. Jordan, **D**. 80 (920); **M**. 130.

Habitat.—Indiana to Tennessee and Arkansas.

119. *Etheostoma evides* (Jordan and Copeland).

Hadropterus evides Jordan and Gilbert, **C.** 5, Eureka Springs. Jordan, **D.** 78 (905).

Etheostoma evides Jordan, **M.** 128.

Habitat.—Indiana to Iowa and Arkansas.

120. *Etheostoma cymatotænia* Gilbert and Meek.

Hadropterus cymatotænia Jordan, **D.** 79 (910).

Etheostoma cymatotænia Jordan, **M.** 128. Meek, **P.** Salado and Caney Creeks at Batesville.

Habitat.—Ozark region.*

121. *Etheostoma scierum* Swain.

Hadropterus scierus Jordan and Gilbert, **C.** 13, Arkadelphia and Benton. Jordan, **D.** 79 (913).

Etheostoma scierum Jordan, **M.** 127.

Habitat.—Indiana to Arkansas and Texas.

122. *Etheostoma zonale* (Cope).

Etheostoma zonale Jordan and Gilbert, **C.** 5, Eureka Springs; **C.** 13, Arkadelphia. (Here mentioned as var. *arcansanum* J. and G.) Meek, **O.** 135, Spring River, at Mammoth Spring; 137, Judsonia; 139, Ouachita, South Fork of the Ouachita, Saline and Caddo Rivers; Meek, **P.** Middle Fork of Little Red River at Kinderhook; Illinois River at Ladd's Mill; Polk Bayou at Batesville; Black and Spring Rivers at Black Rock; Illinois Bayou at Russellville; Middle and Main Forks of White River at Fayetteville.

Habitat.—Western Pennsylvania to Kansas and Mississippi.

123. *Etheostoma flabellare* Rafinesque.

Etheostoma flabellare Jordan, **D.** 80 (923); **M.** 131. Meek, **P.** Illinois River at Ladd's Mill.

Habitat.—Western New York to North Carolina and westward.

**Etheostoma nianguæ* Gilbert and Meek.

Hadropterus nianguæ Jordan, **D.** 79, (911); **M.** 129.

Habitat.—Southern Missouri and Kentucky; it probably occurs in Arkansas.

124. *Etheostoma stigmæum* (Jordan).

Etheostoma stigmæum Jordan, **D.** 78 (891). Meek, **O.** 139, Ouachita River near Bear City, South Fork of the Ouachita, and Caddo River at Caddo Gap.

Etheostoma saxatile Jordan and Gilbert, **C.** 13 Benton.

Habitat.—Tennessee to Arkansas and south.

125. *Etheostoma punctulatum* (Agassiz).

Etheostoma punctulatum Jordan, **D.** 80 (933); **M.** 132. Meek, Salado and Caney Creeks near Batesville.

Habitat.—Ozark region.*

126. *Etheostoma whipplei* (Girard).

Boleichthus whipplei Girard, **B.** 1859, 103, Coal Creek, Arkansas.

Etheostoma whipplei Jordan and Gilbert, **C.** 9, Ft. Smith; **C.** 13, Arkadelphia and Benton. Jordan, **D.** 81 (934); **M.** 131. Gilbert, **E.** 609, Waldron. Meek, **O.** 139, Ouachita River basin; Polk Bayou at Batesville; Spring River at Black Rock; Illinois Bayou at Russellville.

Habitat.—Ozark region and southward.

127. *Etheostoma cæruleum* Storer.

Etheostoma cæruleum Jordan, **D.** 81 (936); **M** 133. Meek, **O.** 135, Spring River at Mammoth Spring.

Habitat.—Western Pennsylvania to Iowa, Arkansas and Kentucky.

This type is found in much less numbers than the following, although usually found with it.

**Etheostoma cragini* Gilbert.

Etheostoma cragini Gilbert, Proc. U. S. Nat. Mus., 1887, 62. The specimens referred to were taken from a tributary of the Arkansas River near Garden City, Kansas.

Habitat.—Southeastern Kansas.

127a. *Etheostoma cœruleum spectabile* Agassiz.

Etheostoma cœruleum spectabile Jordan and Gilbert, **C**. 5, Eureka Springs; **C**. 13, Arkadelphia and Benton. Jordan, **D**. 81 (936); **M**. 133. Meek, **O**, 135, Spring River, Spring Branch, Myatt and English Creeks at Mammoth Spring; Meek, **P**. Spring and Black Rivers at Black Rock; Big Spring, Lafferty Creek and Polk Bayou at Batesville; King's River at Marble; Jordan's Creek at Dutch Mills; Walnut Fork of Piney at Swain; Flat and Machine Creeks at Smithville; Illinois River at Prairie Grove; Big Buffalo at Loafer's Glory; Middle Fork of Little Red River at Kinderhook; Middle Fork of White River near Fayetteville.

Habitat.—Indiana to Arkansas and Kansas.

Where *E. cœruleum spectabile* is found in large numbers a few of the true *E. cœruleum* type are also found. The graduation is very complete, most localities given for the varieties may also answer for the species, but they are not duplicated in this paper.

127b. *Etheostoma cœruleum lepidum* (Girard).

Etheostoma lepidum Jordan, **D**. 81 (935).

Etheostoma cœruleum lepidum Gilbert, **E**. 609, Waldron.

Habitat.—Western Arkansas.

128. *Etheostoma jessiæ* (Jordan and Brayton).

Etheostoma jessiæ Jordan, **D**. 81 (937); **M**. 133.

Habitat.—Tennessee to southern Indiana, Iowa and Texas.

129. *Etheostoma fusiforme* (Girard).

Etheostoma fusiforme Jordan and Gilbert, **C**. 9, Ft. Smith; **C**. 13, Arkadelphia and Benton. Jordan, **D**. 81 (941); **M**. 134. Meek. **O**. 137, Judsonia.

Habitat.—Massachusetts to South Carolina, Indiana, Arkansas and Texas.

130. *Etheostoma microperca* Jordan and Gilbert. Least darter.

Alvarius punctulatus Jordan, **D.** 81 (945).

Etheostoma microperca Jordan, **M.** 134. Meek, **O.** 137, Judsonia; Little Red River at Heber; Illinois Bayou at Russellville.

Habitat.—Northern Indiana to Minnesota and Arkansas.

131. *Etheostoma fonticola* Jordan and Gilbert.

Alvarius fonticola Jordan and Gilbert, **C.** 13, Arkadelphia. Jordan, **D.** 81 (946).

Etheostoma fonticola Gilbert, **E.** 609, Waldron.

Habitat.—Arkansas and Texas.

51. Stizostedion Rafinesque.

132. *Stizostedion canadense* (C. H. Smith). Sauger; sand-pike.

Stizostedion canadense Jordan and Gilbert, **C.** 8, Ft. Smith. Jordan, **D.** 81 (949); **M.** 135. Meek, **P.** Illinois Bayou at Russellville.

Habitat.—Great Lake region to Dakota and Arkansas.

Smaller than the next.

133. *Stizostedion vitreum* (Mitchill). Wall-eyed pike; salmon; jack salmon.

Stizostedion vitreum Jordan and Gilbert, **C** 8, Ft. Smith. Jordan, **D.** 81 (948); **M.** 135.

Habitat.—Great Lakes, Mississippi Valley and east to Virginia.

This species reaches the weight of 16 to 20 pounds. It is an excellent game and food fish. It is pisciverous and even more ravenous than the black bass.

Family 21. SERRANIDÆ. (The sea bass.)

52. Morone Mitchill.

134. *Morone interrupta* Gill. Yellow bass.

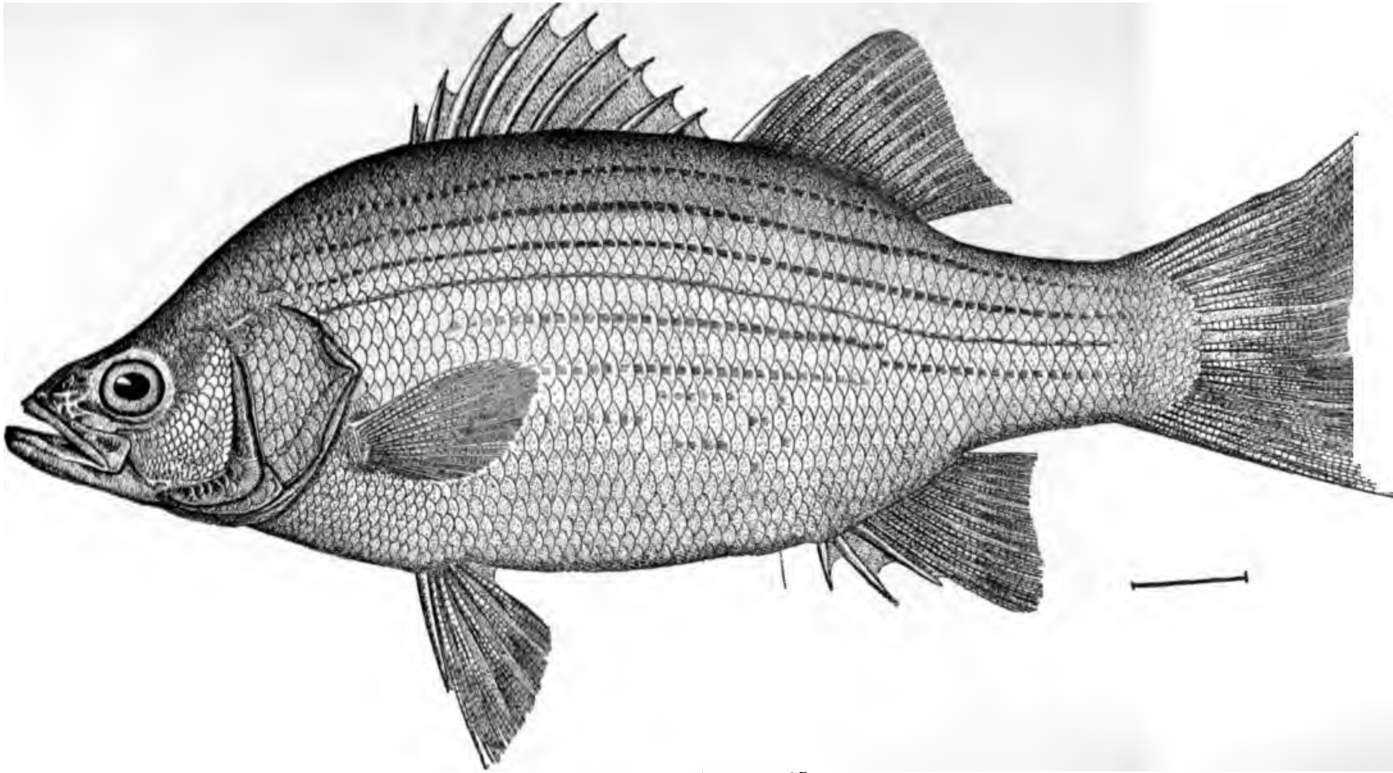
Roccus interruptus Jordan, **D.** 82 (956).

Morone interrupta Jordan, **M.** 137.

Habitat.—Mississippi Valley.

This species inhabits large streams; though small it is a good food fish. It feeds chiefly upon crustaceans and insects.

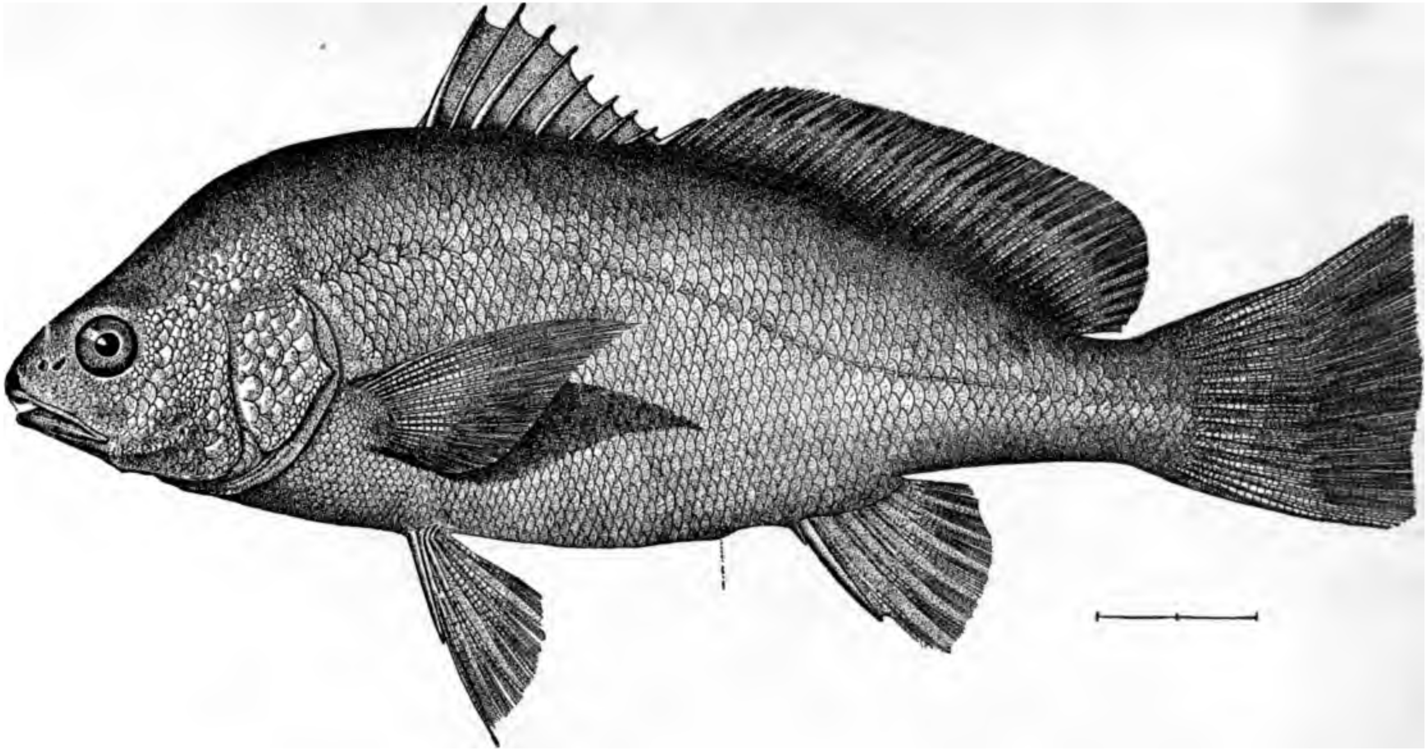
PLATE XI.



WHITE BASS.

Roccus chrysops Rafinesque. (Page 275.)

PLATE XII.



DRUM; SHEEP'S HEAD; CROAKER.

Aplodinotus grunniens (Rafinesque.) (Page 275.)

53. Roccus Mitchill.

135. *Roccus chrysops* Rafinesque. White bass.

Roccus chrysops Jordan and Gilbert, **C**. 12, Arkadelphia and Benton; **C**. 14, Fulton. Jordan, **D**. 82 (955). Meek, **P**. White River at Batesville; Spring River at Black Rock; Arkansas River at Mulberry.

Habitat.—Mississippi Valley north to central Indiana and Illinois.

FAMILY 22. SCIÆNIDÆ.

54. APLODINOTUS Rafinesque.

136. *Aplodinotus grunniens* (Rafinesque). Fresh-water drum; sheeps-head; croaker; white perch.

Amblodon grunniens Girard, **A**. 96. Near mouth of Poteau River and at Ft. Smith.

Aplodinotus grunniens Jordan and Gilbert, **C**. 14, Arkadelphia, Benton and Fulton. Jordan, **D**. 93 (1083); **M**. 144. Meek, **O**. 128, Spadra Creek at Clarksville; Arkansas River at Little Rock and Mulberry; Little Red River at Judsonia; East Fork of Cadron Creek near Conway.

Habitat.—Great Lakes to Texas and Georgia.

This species reaches a length of two feet. It is coarse, though much used for food.

FAMILY 23. COTTIDÆ. (The sculpins.)

55. COTTUS (Artedi) Linnæus.

137. *Cottus bairdi* (Girard). Miller's thumb; blob; cod.

Uranidea richardsoni Jordan and Gilbert, **C**. 6, Eureka Springs.

Cottus richardsoni Meek, **P**. White River, at Oxford Bend; Spring Creek and Polk Bayou at Batesville; Illinois River at Ladd's Mill and Prairie Grove; King's River at Marble. Jordan, **M**. 149; **D**. 111 (1320).

Cottus bairdi Meek, O. 135, Spring River at Mammoth Spring.

This is a very variable species. It reaches a length of about ten inches. The largest specimens found are from Arkansas. At Mammoth Spring this species was found very abundant below the dam; the citizens there call it "cod;" it lives in clear, cool water and is of no special importance.

THE

GEOLOGY OF DALLAS COUNTY

BY C. E. SIEBENTHAL, A. M.,
Assistant Geologist.

CONTENTS.

PREFACE.

The drainage on the accompanying map was taken from the land office plats and corrected by personal observation in the field. The roads and flood plains were obtained from field observations and from information furnished by persons living in the region. The elevations given were determined with the aneroid barometer, the readings being checked by the readings for the same period of the standard mercurial barometer in the United States Signal Service office at Little Rock; as much error was eliminated as could be detected by double readings, and the resulting elevations tied upon and checked by the spirit levels of the St. Louis, Iron Mountain & Southern Railway at Malvern, and of the Ultima Thule, Arkadelphia & Mississippi Railway at different points in the county. While aneroid determinations are never perfectly satisfactory, it is believed that the elevations given are fairly trustworthy.

THE GEOLOGY OF DALLAS COUNTY.*

By C. E. Siebenthal, A. M.

Topography.

Dallas county, Arkansas, is in the south central part of the state entirely within the Tertiary area, and its topography is of that undulating character common to regions of soft and easily eroded strata. As in other portions of the Tertiary area the rocks are soft clays, sands, and brown coals variously interstratified and horizontally bedded, the whole overlain by an irregular covering of coarse sand and gravel. The northwest quarter of the county is the highest, and from this region it slopes eastward and southward.

Plateau ridges.—The Malvern-Princeton road for almost its whole length traverses the water-shed between the Saline and Ouachita rivers—a flat gravelly ridge of about 550 feet elevation. This represents the gravelly plateau of that elevation which was left after the subsidence of the waters by which the gravel was deposited. The ridge divides around the head of Cypress Creek in Hot Spring county, and the western end maintains its original elevation to the vicinity of O'Neill's Mill in the northwestern part of Dallas county. The ridge is here wide and flat, descending south until, in the neighborhood of Dalark, it is about 260 feet above sea level. The other

*The following references comprise the only geological literature relating directly to Dallas county.

In 1860, Professor Leo Lesquereux, in the second report of the Geological Reconnoissance of Arkansas, by D. D. Owen, pp. 318–319, mentioned the occurrance of lignite on Little Cypress Creek. Again, p. 342, he describes the characteristic soils and flora of Dallas county.

Dr. R. A. F. Penrose, Jr., in the annual report of the Geological Survey of Arkansas for 1892, Vol. I., pp. 117–118, describes the iron ores of the county and gives analyses of the glauconite ore from Griswold's Mill.

part of the main ridge divides again around the head waters of Tulip Creek. That part between West Tulip and Cypress Creeks cultimates in a sharp hill near the Princeton-Arkadelphia road, while the other part continues to Tulip, where it has an elevation of 480 feet. South of Tulip it divides around East Tulip Creek. The western division ends in the prominent hill, 460 feet in elevation, on which stands the Welch Pottery. The eastern part gradually gets lower toward the south until east of Princeton it has an elevation of less than 300 feet above tide.

Foot-hills and flatwoods.—South and east of the flat ridges the more elevated country is broken up into a succession of small, more or less rugged hills, which as one goes farther away from the flat ridges and approaches the Ouachita or Saline, get lower and lower, and finally become gentle undulations. This region is covered with a heavy growth of pine and white oak. The soil of the flatwood is a dark and rather heavy loam.

In the southwestern part of the country lying between the Holly Springs-Fairview road and the overflow country of the Ouachita, is an area which is almost flat and upon which, excepting hummocks, the water stands for a time after a rain. The soil from the higher portions washes down and spreads over this portion causing it to resemble an alluvial soil. It is heavily timbered with pine.

Flood-plains.—The alluvial plains of all the larger streams, exclusive of the Ouachita and Saline which have wider bottoms, vary from one-fourth of a mile to one mile in width. Their area is shown within the dotted lines on the accompanying map. During heavy freshets this area is overflowed. The timber of these bottoms consists of beech, gum, maple, holly and cypress.

General Geology.

Water-worn material and conglomerate.—When Dallas county for the last time rose from the sea, the plain of which it then consisted was covered with a sheet of water-worn material

which was in some places 25 feet thick. The erosion to which this plain has since been subjected has cut it down in places 200 or 300 feet below the original level (the original level being represented probably by the flat ridges described above,) and this action has disturbed the original arrangement of the water-worn material. In some places it is thicker than originally, and from others it has nearly all been removed. In some places its position is occupied by a heavy bed of sand, notably in township 7 S., 16 W., section 9, the northwest quarter of the northeast quarter, where at Mrs. Cox's a well passes through 64 feet of yellow and red sand with no clay. This water-worn material consists of white quartz, sandstone, and novaculite pebbles, ranging from the size of a pea to one or two inches in diameter, together with more or less ferruginous sandy clay.

Upon the flat tops of the plateau ridges the water-worn material is practically undisturbed. It is from 25 to 30 feet in thickness and consists of pebbles of varying size, and a coarse ferruginous sand. On the breaks of these ridges this covering of sand and gravel has been eroded and the underlying plastic clays outcrop in the gullies. In the higher foot-hills adjoining the flat-topped ridges there is practically the same disposition of the gravel as in the plateau ridges, but in the lower portions and flatwoods it is quite different. Here transportation and sorting give rise in places to the large beds of red ferruginous sand mentioned above, and in other places to beds of red and bluish mottled clay. This clay is of very common occurrence, especially in the southern part of the county. It appears to be the result of an admixture of the plastic clay with the ferruginous sand. The body of the clay is a bluish white and intersperced through this are blotches of very red sandy clay. The clay varies in plasticity but in general is only moderately plastic, owing to an excess of sand. It has also too much iron in it to be used as a potters' clay. It may grade into a bed of red sand with blotches of bluish clay in it.

Where the land is flat and inclines to be marshy the top clay is the characteristic gray sandy clay so much used in building

chimneys and known locally as "post oak flat clay." This deposit is formed by the transportation and admixture of the sand and plastic clays with more or less surface soil and organic matter. Gravel is not uncommon in this clay; its gray color is probably due to the action upon it of organic acids.

Pudding-stone or conglomerate.—Pudding-stone or conglomerate (locally known as cement rock,) occurs in many places, but not at any fixed horizon. It is composed of pebbles identical in size and character with those of the water-worn material. They are cemented together by a highly ferruginous sand, the result probably of percolating chalybeate waters such as often emerge from the beds of gravel and sand. In one place, township 7 S., 16 W., section 8, the southeast quarter of the northeast quarter, the conglomerate forms a bed four feet in thickness, capping a little knoll. In other places it also occurs in ledges or beds, varying from two to four feet in thickness; and it occurs in loose fragments scattered over the southern half of the county.

Lignite or brown coal.—Beds of lignite or brown coal, varying from one foot to four or five feet in thickness, occur frequently, and some are reported to be as much as six or eight feet thick. The elevation of these occurrences so far as they came under the observation of the Survey, were carefully noted, and approximate elevations determined for such as were reported. This was done in the hope that some of the beds might prove continuous over considerable areas and thus throw light on the stratigraphy of the clays. It is not thought, however, that the fact that lignites in different parts of the county are at the same elevation proves the continuity of the lignite bed. In fact, observations in the field show conclusively that there is no such continuity. It is contended, however, that these localities were contemporaneously under conditions favorable for the preservation of vegetable matter and are therefore correlative. It is not likely that beds not approximately at the same level when laid down, should be so shifted that the scattered localities in question, would be brought to the same elevation. Out of more than a dozen occurrences of lignite, one-half

seem to be easily reducible to the elevation of 270 feet above tide. These are distributed quite widely over the county, and seem to prove that within the county the strata have no perceptible dip to the east. Four of the other occurrences are near 320 feet in elevation; two are 220 feet; and the other three, something over 400 feet above tide. The occurrences of lignite are given below.

Occurrences of Lignite or Brown Coal.

On the Cheatham place, three or four feet of lignite is exposed in a bluff on the east side of Dry Tulip Creek in 9 S., 15 W., section 22, the northwest quarter of the northeast quarter. The lignite occurs at an elevation of 270 feet above tide. (See section, page 293.)

In P. N. Lantorn's well in 8 S., 15 W., section 8, the southeast quarter of the northeast quarter, a three-foot bed of lignite was struck at an elevation of 310 feet above tide.

Lignite three feet in thickness was reached at an elevation of 430 feet above tide in Mrs. Green's well in 8 S., 15 W., section 5, the southwest quarter of the northwest quarter.

In A. Whitener's well in 8 S., 15 W., section 3, southwest quarter of the northwest quarter, a foot of lignite was found at the elevation of 460 feet.

Five feet of lignite occurs in Wiley Canler's well in 10 S., 15 W., section 8, northeast quarter of the northwest quarter, at an elevation of 220 feet. This bed is said to outcrop also in a bluff in the immediate neighborhood.

Lignite outcrops in three places in 8 S., 17 W., section 36, west half. The bed is three feet thick and has an elevation above tide of 220 feet.

A three-foot bed of lignite outcrops in the bank of a stream in 10 S., 14 W., section 8, northeast quarter of the northwest quarter. The elevation of the bed above tide is 260 feet. It is underlain by slate-colored plastic clay, and above shades into a three-foot bed of light brown lignitic clay. This lignite outcrop is 100 yards south and down-stream from the Wormac clay bank under which it seems to dip.

Lignite is reported to come just under the Dellamar clay in 8 S., 17 W., section 14, southwest quarter of the northwest quarter. The elevation above tide is 310 feet.

Lignite is reported in Mrs. Dedman's well, in 9 S., 15 W., section 3, southwest quarter. The elevation above tide is about 270 feet.

Lignite occurs at the elevation of 270 feet in B. Barbee's well, in 7 S., 14 W., section 23, the south half.

In J. S. Young's well in 7 S., 16 W., section 2, northeast quarter of the southwest quarter, a bed of liginite, a foot and a half in thickness was found at an elevation of 415 feet.

A three-foot bed of lignite outcrops in a branch near the creek, in township 8 S., 15 W., about 400 yards east of the southwest corner of section 4, at the elevation of 350 feet.

Lignite is marked on the United States Land Office plats as occurring in 7 S., 17 W., in the neighborhood of the southwest corner of section 24 near Little Cypress Creek. It outcrops in the bank of the creek and is from four to five feet thick. Lesquereux* notes one or two feet of lignite on Little Cypress Creek, which is very probably the same outcrop. The elevation is 330 feet.

Lignite is reported to occur as follows:

In the bank of a stream in 7 S., 14 W., section 5, southwest quarter of the southwest quarter on the H. T. Riggins land, a bed of seven or eight feet in thickness. The elevation is about 280 feet.

A bed from three to six feet thick is reported to occur in wells in 7 S., 13 W., section 18. The elevation here is about 280 feet.

Four feet of lignite is reported on Mathews Creek in 8 S., 14 W., in the vicinity of section 4. The elevation is probably about 270 feet.

Sandstone.—There is very little sandstone in Dallas county. The principal use to which that little is put is in building chimneys, brick not having come into great demand as yet

*A Geological Reconnoissance of Arkansas, second report, by D. D. Owen, pp. 317-318.

for such purposes. The heaviest outcrops seen occur in the northwestern part of the county. In 7 S., 16 W., about 440 yards west of the southeast corner of section 5, there is an exposure of three feet of soft yellow ferruginous sandstone. It is reported that sandstone has been taken from just beneath the ledge exposed. Further west in 7 S., 16 W., the southwest quarter of the northeast quarter, two or three feet of sandstone is exposed. This bed caps the hills in that neighborhood. When freshly exposed it is soft and ferruginous, but becomes hard and indurated on exposure. These two outcrops are the heaviest observed and occur at about the same elevation—460 feet above tide.

A thin bed of sandstone occurs at an elevation of 280 feet in the Cheatham section (see page 293), and again at the same elevation in the road in 8 S., 14 W., in section 6, and a similar bed is plowed up east of Pinchback's mills at the same elevation.

A bed of ferruginous sandstone outcrops in the Sandy Springs-Ivy road, in 7 S., 14 W., section 5, southeast quarter of the southwest quarter, at an elevation of 280 feet.

Sandstone occurs between Sand Creek and Beech Creek in 9 S., 15 W., sections 21 and 22. This place was not visited by the writer but judging from the surrounding topography the elevation is not far from 280 feet.

Fragments of sandstone are quite plentiful all over the county, but in no other place than the above was the elevation taken except in 7 S., 16 W., section 32, northwest quarter of the northwest quarter, where a great many pieces of hard, white, quartzitic sandstone were observed at an elevation of 340 feet.

It will be noticed that nearly all of the above outcrops come at the elevation of 280 feet.

Leaf-bearing clays.—The only fossils known to occur in Dallas county are the scattered fragments of silicified wood and the leaf impressions contained in a few beds of clay. In no instance was the silicified wood observed in place nor could a definite horizon be established for the leaf impressions, so the distribution of silicified wood and leaf impressions throws no

light on the stratigraphy of the clays. The leaf impressions collected have not been identified owing to their fragmentary condition.

The locality where leaf impressions appear most abundant is in 7 S., 15 W., section 2, southwest quarter of the northwest quarter. In a gully just west of the Tulip-Sandy Springs road, there is an exposure of 15 feet of clay resting on white sand and overlain by gravel and red sand. The lower seven or eight feet is white plastic clay. The upper part of the bed is a brownish drab joint clay containing much sand. About one foot of this bed is completely filled with leaf impressions, there being so many that the bed has at this place the color of dead leaves. The elevation of this place above tide is 360 feet.

Leaf impressions are reported in a five-foot bed of bluish clay in a well just west of Nix post-office, in 8 S., 16 W., section 33, northwest quarter of southwest quarter.

In an abandoned well about 500 yards north of Mr. Stell's house at Stony Point, leaf impressions were found in leaden-colored sandy clay. The elevation above tide of the mouth of the well is about 290 feet.

A few leaf impressions are found in 30 feet of white pipe clay and in ten feet of dark clay in Douglas Ratliffe's well, in 8 S., 17 W., section 2, southeast quarter of the southeast quarter. Elevation above sea level 290 feet.

Leaf impressions occur in 13 feet of dark clay in W. L. Patterson's well, in 10 S., 16 W., section 33, northeast quarter of the northeast quarter. Elevation above sea level 200 feet.

In J. T. Shankle's well, in 10 S., 15 W., section 7, southeast quarter of the northwest quarter, leaf impressions are found in 22 feet of dark clay with harder lumps, apparently similar to the clay in the two preceeding wells. Elevation above sea level 300 feet.

A similar bed of clay ten feet thick shows leaf impressions in W. M. Walsh's well, in 10 S., 16 W., section 1, northeast quarter of the northwest quarter. Elevation above sea level 265 feet.

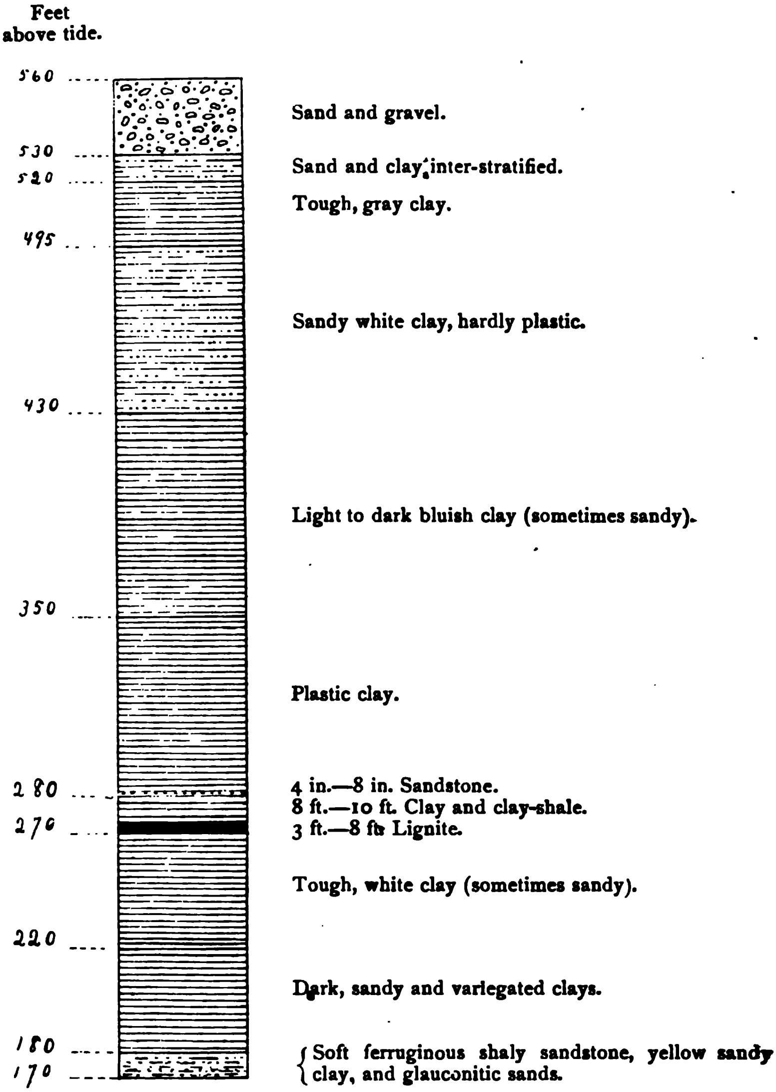
Stratigraphy.—The apparent constancy over a large part of the county of the lignite bed at 270 feet and of the sandstone

stratum at 280 feet seems to indicate that the strata are nearly level. Only one dip was obtained in the county, this was a south-southeast dip of 6° or 8° observed in a bed of white sand ten feet in thickness, on the banks of Gass' Creek in 7 S., 15 W., section 3. This bed of sand occurs at the elevation of 330 feet, and as no other deposit of like nature was noticed at that elevation, we are justified in regarding it as purely local.

The heavy sandstone strata in the western part of the county at the elevation of 460 feet, were not observed east of Cypress Creek, so it is propable that they thin out just west of that creek.

All of the sections obtained were platted on one sheet at their proper elevation, to see if the beds would indicate any definite dip to the southeast. The result, while presenting some obstacles to horizontal interpretation, furnishes the same difficulties to any view of a general inclination of the strata, and in addition fails to give any evidence in favor of such a view. To accept the horizontality of the strata, we must assume that the beds of lignite are of local extent, and that the beds of clay vary greatly in character and thickness within limited areas.

If we accept, then, the horizontality of the strata we may construct as follows a tentative generalized section of the county from the highest to the lowest points observed.



Generalized section in Dallas county.

It must be borne in mind that this section is a compilation of all the sections observed, and as such will only by a mere coincidence fit the conditions of any particular section. It will be noticed that there are several heavy beds of clay in the

section. It is hardly probable that in any particular section the clay will be found so thick, but taking all the sections, more clay of the description was found between the specified elevations than anything else, so the whole distance between the elevations was put down as that particular kind of clay. The extreme variability of the clay and sand, both vertically and horizontally, renders all attempts at stratigraphical correlation by lithologic characters of but little value.

The geological history of Dallas county.—The pre-Tertiary history of Dallas county within the county itself is entirely obliterated by later deposits, but the physical conditions which obtained during a part of Tertiary time and during post-Tertiary times are recorded in the deposits now exposed and in the topography. The general section given in the preceding pages shows an alteration of 400 feet of soft sandstones, sandy clays, plastic clays and lignite. The bed of glauconite (green sand) at Griswold's mill* represents the lowermost member in the general section. Modern glauconite sands are internal casts of the shells of Foraminifera and other marine organisms, and are deposited most plentifully between low tide mark and 100-300 fathoms depth.† These modern glauconite sands are completely analogous in form, character and composition to the glauconite sands found in all geologic formations from Cambrian to Tertiary. The glauconite at Griswold's mill marks the transition from the marine conditions of the Cretaceous to the shallow water conditions which prevailed while the later deposits of sands, clays, and lignites were being laid down in Dallas county.

Professor Gilbert D. Harris, who has prepared a report for the survey upon the Tertiary geology of the southern part of the state visited Griswold's mill, and speaks as follows of that locality: "On the right bank of Tulip Creek not far below the junction of its east and west forks, there is a low bluff of indurated and concretionary sandstone. This is in 10 S.,

*See Annual Report of the Geological Survey of Arkansas for 1892, Vol. I., pp. 117-118.

†Challenger Reports; Deep Sea Deposits, pp. 378 *et seq.*

16 W., section 4, about two or three rods above Griswold's mill. The upper portion of this bluff, which is about 15 feet in height, consists of loose yellow sand layers separated by bands of thin, firm, ferruginous, sandy clay. Below, the material is more indurated and is formed into concretionary masses of from half a foot to ten feet in diameter. More especially in the lower part of this bluff there are greenish particles mixed with the sand, and also traces of lignite. Mr. Daniels, one of the proprietors of the mill, found a "perfect Dogwood leaf" in one of these concretions, and it was reported that sea shells had been found while blasting the rocks at a point perhaps ten feet above the surface of the water. They were described as resembling small clam shells, and if the report be true, they were probably species of *Cytherea*. Several hours of digging and rock breaking at this place, however, failed to reveal a single trace of animal remains.

It is believed that if determinable molluscan species are to be found in the Lignitic of Arkansas at all, they will most probably occur in the southwestern part of this county. Several small areas of red-lands were described as occuring in this region, but time was too limited to admit of visiting them. Again, the owner of the farm just south of Mr. Daniels' stated that he had found a hog's tusk in his well at a depth of no less than twenty-five feet below the surface. This, if a tooth at all, was probably that of a shark, and would indicate that at least some forms of marine life were able to exist in the brackish waters that characterized the Lignitic age."

Some of the clays contain impressions of leaves, but no marine animal remains are known surely to have been found in the county, though some have been reported, as mentioned above. The soft sandstones were laid down as near shore deposits, the plastic and sandy beds containing leaf impressions were deposited in quiet waters, possibly in lagoons, and the lignites were formed in swamps. These deposits point to a brackish water condition, or to an alternation of brackish and fresh water conditions, either of which would account for the great scarcity or the entire absence of marine fossils.

Whether a period of erosion ensued between the deposition of the uppermost bed of clay in the general section and the deposition of the overlying gravel cannot be positively affirmed or denied, but from the fact that the plateau ridge tops, just beneath which the clay comes, are uniformily flat and covered with a nearly uniform thickness of sand and gravel, it is inferred that no period of erosion intervened. At some time subsequent to the deposition of this uppermost bed of clay—but whether during Tertiary or post-Tertiary time we cannot say—the land subsided until the sea washed and broke upon the sandstones and novaculite ridges of the Ouachita uplift.* When the land was again elevated, the quartz, sandstone and novaculite pebbles which had accumulated along the shore were drawn out by the undertow of the retiring waters and strewn over the Tertiary deposits.

When the gravel-covered plain became land, rudimentary drainage had already been established by the subsiding sea, and this in the course of time developed into the present system of drainage and gave the country its topographic features. The rolling nature of this topography is due to the looseness and softness of the sands and clays.

While the valleys were being carved out and the hills shaped into their present forms, the gravels and sands were shifted and sorted and the clays and sands were transported and mixed with humus. This mixture, more or less leached by organic and atmospheric agencies, forms most of the soils of the county.

ECONOMIC GEOLOGY.

POTTERS' CLAYS.

That there is potters' clay in practically unlimited quantities in Dallas county has been shown by the present investigation, and that it is of good quality is demonstrated by the favorable comparison of wares made therefrom with wares made from clay from other localities. It has been locally used to a

*For a description of the Ouachita uplift, see the Annual Report of the Geological Survey of Arkansas, for 1890, Vol. III, pp. 207–210.

small extent as fire-clay, in laying up furnaces, etc. It has also been used as a whitewash and when so used it gives a smooth coat of a pleasing, slightly bluish tint. For such purposes it is dissolved in buttermilk and boiled, and it is claimed that the composition furnishes about as durable a coating as that made with lime.

To what extent it has been used for pottery is shown in the historical sketch at the end of this chapter. It has been found that potteries here cannot compete except in local markets with potteries situated on the railways, and working clay equally good. The future of the pottery industry in Dallas county depends therefore upon the facility of transportation of the product to markets.

Detailed description of the clay beds.

Since the stratigraphy of these clays has not been worked out in sufficient detail to allow us to take up the beds in the order of their natnral sequence, it is perhaps best, first to describe in detail those beds which have at one time or another been opened and worked, together with those of which the clays have been analyzed, aud afterwards to take up the miscellaneous outcrops and well records.

The Butler clay.—The first bed to be opened in Dallas county was in all probability that which became known as the Butler bed. This bed is in township 8 S., 15 W., section 4, about 400 yards east of the southwest section corner, and on the west bank of a head of East Tulip Creek, at an elevation above tide of 350 feet. Clay has not been taken from this pit for many years and the only remains of early operations are seen in the hollow which was scooped out of the creek bank and has since filled with debris. In a gulley a hundred yards or so north of this opening, four feet of lignite outcrops, and is overlain by a plastic white clay, similar to Tall's clay which occurs something like a half mile north of this place. (See page 298.) Clay was also taken from an old field about a quarter of a mile south of the first mentioned opening, but the old pit has long since filled up with debris.

The Cheatham clay—Upper bed.—The next bed to be opened was the Cheatham bed on Dry Tulip Creek, in 8 S., 15 W., section 22, the northwest quarter of the northeast quarter. The bed was worked back a little way from the creek on a small drain, but no exposure can now be seen on account of the debris that conceals the bed. On the creek bank about 100 yards south of this locality the following section is exposed at an elevation above tide of 260 feet.

Section near Cheatham's Upper bed.

	Feet.
Soil and gravel	2
Argillaceous shale	4
Soft sandstone	3½
Clay and shale	2
Lignite	1
Stiff clay (partly concealed	4
Lignite	3–4
White, plastic clay	5

Lower bed.—Clay has also been taken from a bluff on the west side of the creek a half mile further south, in the southwest quarter of the northeast quarter of the same section. The elevation above tide is 255 feet. From six to eight feet of gray, stone-colored, joint-clay is exposed. The lignite bed of the upper bank was not observed here but the upper part of the bluff is covered with debris. The clay is fine-grained with some grit and clings strongly to the tongue. This clay has been used more extensively than any other in the county and has uniformily been pronounced good by potters.

Analysis of Cheatham's pottery clay.

		Per cent.
Silica	(SiO_2)	72.82
Alumina	(Al_2O_3)	13.72
Ferrous oxide	(FeO)	1.14
Titanic oxide	(TiO_2)	2.54
Lime	(CaO)	.63
Magnesia	(MgO)	.75
Soda	(Na_2O)	1.08
Potash	(K_2O)	.96
Loss on ignition (combined water and organic matter)		5.76
Total		99.04
Hygroscopic moisture (water in air-dried clay at 115°C.)		1.94
Sand in air-dried clay		50.30
Refractoriness by Bischof's revised formula*		.20

Were it not for the fact stated above that this clay has been extensively and successfully used for pottery, its availability for such purposes might be doubted. Its weak refractoriness is undoubtedly due to its low percentage of alumina as compared with the silica, for it has only moderate percentages of the fluxes.

The Bird clay.—The Bird clay bed outcrops on the hillside near one of the small streams flowing from the south into Cox's Creek, in township 7 S., 15 W., section 6, the northwest quarter of the northeast quarter. The same clay crops out westward on up and around the head of Cox's Creek, and then eastward along the breaks of the hills skirting the north edge of Gum Bottom. The elevation above tide of the portion of the bed which was worked is 390 feet, but clay of apparently the same quality outcrops in places in the drain all the way up to the elevation of 440 feet. This would make the bed something like 50 feet in thickness. At the pit about 15 feet is exposed. William Bird, who discovered and worked this clay, claimed that it was the best in the county for pottery. It is said to have the disadvantage of being difficult to dry without cracking. This could be remedied by a judicious admixture of other clays. The clay when freshly exposed is light bluish

*Bischof's formula has been revised by Drs. J. C. Branner and J. F. Williams. It is given in the Survey's report on clays, Vol. I. of the Annual Report for 1889.

in color and very plastic. It is very fine-grained and has but little grit. The specimen analyzed came from within a foot of the surface and had somewhat weathered and lost its joint-like character.

Analysis of Bird's pottery clay.

		Per cent.
Silica	(SiO_2)	66.42
Alumina	(Al_2O_3)	21.19
Ferrous oxide	(FeO)	1.76
Titanic oxide	(TiO_2)	1.02
Lime	(CaO)	1.13
Magnesia	(MgO)	.82
Soda	(Na_2O)	1.26
Loss on ignition		7 76
Total		101.36
Hygroscopic moisture at 115°C		3.60
Sand in air-dried clay		37.28
Refractoriness by Bischof's revised formula		.45

The analysis indicates a good clay, the silica and alumina in good proportion, and the percentages of the fluxes very moderate. As stated above, the quantity of this clay is almost unlimited.

The Welch clay.—This bed was found and opened by John Welch. It is located in township 8 S., 15 W., section 6, the southeast quarter of the southwest quarter. The elevation of the bed is 355 feet above tide, making it correspond very closely with the Butler clay described above. The bed has been dug into seven or eight feet and the quality improved and the color became lighter as greater depth was reached. The clay occurs in angular lumps, is light bluish gray in color and very fine-grained with little grit. Mr. Welch reports that the joint spaces are filled with a crystalline substance somewhat resembling common salt, and that particles of this substance become embedded in the ware and make blisters when burning. Samples of ware made from this clay are hard and close bodied. It burns to a gray slate color when perfectly done, the softer pieces varying from yellow to brown.

Analysis of Welch's pottery clay.

		Per cent.
Silica	(SiO_2)	71.27
Alumina	(Al_2O_3)	16.86
Ferrous oxide	(FeO)	2.14
Titanic oxide	(TiO_2)	1.75
Lime	(CaO	.73
Magnesia	(MgO)	.77
Soda	(Na_2O)	.46
Potash	(K_2O)	.44
Loss on ignition		6.54
Total		100.96
Hygroscopic moisture at 115°C		1.78
Sand in air-dried clay		30.50
Refractoriness by Bischof's revised formula		.31

Mr. Welch reports that he is unable to use the common slip glaze on this clay for the reason that the heat necessary to melt the glaze melts the ware also; and that he is compelled to glaze with common salt, which, however, does very well. The refractoriness of the Albany slip glaze—the one in most common use—as calculated by Bischof's revised formula is very low, only .07, while the refractoriness of the Welch clay as given above is fairly high. Unless the sample of the Welch clay which was analyzed is more refactory than the average, and we think it is not, some agent must have exerted a powerful fluxing effect in the trials which were made with the slip glaze. Systematic experiment would probably show the clay to work very well with slip, or would at any rate reveal the fluxing agent. Sufficient has been said above in regard to the quality of the ware made from this clay to indicate the quality of the clay. It shows to some extent a feature mentioned in connection with the Bird clay, that is, a tendency to crack and warp in the dry house.

The Sullenbarger clay.—The Sullenbarger clay bed is in township 8 S., 15 W., the northeast quarter of section 20. The clay was used by Lafayette Glass in 1870. Nothing can be seen of the clay used, as the pit has long since filled up, but a couple of hundred yards north, up the drain, five or six feet of rather dark gray clay outcrops, and this is reported to be similar to

that used. It contains considerable sand and while not very plastic, has a soapy feel when rubbed in a damp state. The ware made from the Sullenbarger clay is thick and somewhat porous. A combination of this clay and the Welch clay was tried by Mr. Welch, who reports that the mixture worked more freely than the Welch clay alone and that there was less liability of cracking in drying or burning. The elevatian of this bed is 260 feet above tide. It is quite difficult to correlate this bed with any which occur in or near the the Cheatham section, although the elevation is practically the same. No outcrop of lignite was observed, nor was any reported in this vicinity. This clay probably comes above the Cheatham section as the clay supplied came from the elevation of 280 feet. If these beds are to be correlated with any in the Cheatham section it is evident that the character changes greatly in that distance.

Green's clay.—This clay is in 8 S., 15 W., section 5, the southwest quarter of the northwest quarter. It outcrops at the elevation of 440 feet about 100 yards north of Mrs. M. C. Green's in a small drain which runs west into Tunstle Creek. The bed exposed is about ten feet in thickness. The clay is light gray in color, is plastic, has little grit, and clings slightly to the tongue.

Analysis of Green's clay.

		Per cent.
Silica	(SiO_2)	68.03
Alumina	(Al_2O_3)	17.19
Ferrous oxide	(FeO)	.53
Ferric oxide	(Fe_2O_3)	3.00
Titanic oxide	(TiO_2)	1.49
Lime	(CaO)	.81
Magnesia	(MgO)	1.00
Soda	(Na_2O)	.54
Potash	(K_2O)	1.00
Loss on ignition		6.31
Total		99.90
Hygroscopic moisture at 115° C.		4.40
Sand in air-dried clay		35.80
Refractoriness by Bischof's revised formula		.23

The refractoriness of this clay is not very high, yet it is not

by any means so low as that of the Cheatham clay which has been very successfully used for pottery. The percentage of sand present is not large enough to be injurious. The analysis as well as the physical appearance gives every indication that the clay could be very successfully worked into ware.

Tall's clay.—This clay comes from Mrs. Chloe Tall's place, in township 8 S., 15 W., section 4, the north half of the southwest quarter, at an elevation of 370 feet. The specimen analyzed came from beneath a half foot of soil and humus, and was much weathered. The clay is light grayish in color and very plastic, with a small quantity of grit which is rather coarse-grained. It includes small lighter or white particles.

Analysis of Tall's clay.

		Per cent.
Silica	(SiO_2)	62.343
Alumina	(Al_2O_3)	20.631
Ferrous oxide	(FeO)	.673
Ferric oxide	(Fe_2O_3)	3.334
Titanic oxide	(TiO_2)	1.556
Lime	(CaO)	.173
Magnesia	(MgO)	.668
Soda	(Na_2O)	.325
Potash	(K_2O)	.729
Phosphoric acid	(P_2O_5)	.126
Sulphuric acid	(SO_3)	.125
Loss on ignition		9.339
Total		100.022
Hygroscopic moisture at 100°-110° C.		3.868
Sand in air-dried clay		16.73
Refractoriness by Bischof's revised formula		.47

This clay closely resembles the Bird clay not only in physical appearance, but also in its chemical composition, the two analyses corresponding remarkably closely to be of clays from different localities. This clay will be found suitable for all uses for which the Bird clay is available. For practical purposes the quantity of this clay is unlimited.

W. A. Crowder's clay.—Crowder's clay is in 7 S., 14 W., section 8, the southeast quarter of the northeast quarter. The bed is exposed about four feet in thickness in the banks and

bed of a small drain which flows into Miller Creek. The elevation here is about 290 feet above sea level. The clay can be seen only in a weathered condition, but as such it is very tough, plastic, has little grit, and is one of the whitest clays examined.

Analysis of Crowder's clay.

		Per cent.
Silica	(SiO_2)	66.336
Alumina	(Al_2O_3)	18.966
Ferrous oxide	(FeO)	.605
Ferric oxide	(Fe_2O_3)	1.436
Titanic oxide	(TiO_2(	1.869
Lime	(CaO)	.256
Magnesia	(MgO)	.225
Soda	(Na_2O)	.800
Potash	(K_2O)	.379
Phosphoric acid	(P_2O_5)	.092
Sulphuric acid	(SO_3)	.820
Loss on ignition		8.130
Total		99.914
Hygroscopic water at 100°–105°C		6.98
Sand in air-dried clay		17.23
Refractoriness by Bischof's revised formula		.60

In refractoriness this clay comes among those so much used for pottery about Benton, Arkansas, and just below the finest china clay from Cornwall, England, which clay it very much resembles in chemical composition. There can be no doubt that its quality is of the best. What is apparently the same bed crops out a half mile east, and search would undoubtedly reveal it in all the hollows in the neighborhood.

The lavender clay.—In township 8 S., 15 W., section 1, southeast quarter, at the elevation of 280 feet, in the bank of a small drain running into Clark's Creek, is an exposure of four or five feet of tough plastic clay with scarcely any grit. With the exception of about one foot in the middle this clay is light gray in color. The middle bed is of a lavender color and has a peculiar odor and a sharp bitter taste.

*Analysis of lavender clay.**

		Per cent.
Silica	(SiO_2)	50.653
Alumina	(Al_2O_3)	25.450
Ferrous oxide	(FeO)	5.497
Ferric oxide	(Fe_2O_3)	.556
Titanic oxide	(TiO_2)	2.591
Lime	(CaO)	.167
Magnesia	(MgO)	.604
Soda	(Na_2O)	.242
Potash	(K_2O)	.742
Phosphoric acid	(P_2O_5)	.102
Sulphuric acid	(SO_3)	.169
Loss on ignition		13.100
Total		100.203
Hygroscopic moisture at 100°–110° C		4.255
Sand in air-dried clay		3.46
Refractoriness by Bischof's revised formula		.66

This very interesting clay deserves a more extended examination than it has been possible to give it in this investigation.

While the analysis holds good only for the middle bed of lavender clay, there is scarcely any room for doubting that the remainder of the four or five feet of plastic clay comes near the lavender clay in composition. The refractoriness and physical characteristics indicate a clay of fine quality. In several places within a mile or so of this occurrence, clay of apparently the same quality outcrops at the same elevation, so that there must be almost unlimited quantities of this clay.

The Ramsey clay.—The Ramsey clay is exposed about half a mile east of Ramsey post-office in 10 S., 13 W., section 9, near the center of the northwest quarter. The clay crops out in a drain beside the Fordyce-Princeton road at an elevation

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*Taking enough of the silica to satisfy the alumina according to the formula $Al_2 O_3.2Si O_2$ (the remaining silica we may regard as free silica) and recalculating this amount together with the alumina and water on the basis of 100, we have,—

$Si O_2$........43.70 Al_2O_3........37.17 H_2O........19.28

which corresponds almost exactly to the formula $Al_2O_3.Si O_2.3H_2O$, the composition of the missing third member of the kaolinite group.

See American Journal of Science, Vol. XLII, July 1891, p. 11: "Newtonite and Rectorite—two new minerals of the Kaolinite Group," by R. N. Brackett and J. F. Williams.

of about 265 feet. The bed is exposed to the thickness of ten feet. The clay is light bluish-gray in color, and very plastic, and the small amount of grit is very fine-grained.

Analysis of Ramsey clay.

		Per cent.
Silica	(SiO_2)	60.700
Alumina	(Al_2O_3)	21.567
Ferrous oxide	(FeO)	1.281
Ferric oxide	(Fe_2O_3)	3.577
Titanic oxide	(TiO_2)	.447
Lime	(CaO)	.469
Magnesia	(MgO)	1.583
Soda	(Na_2O)	9.297
Potash	(K_2O)	1.526
Phosphoric acid	(P_2O_5)	.093
Sulphuric acid	(SO_3)	.076
Loss on ignition		8.608
Total		100.224
Hygroscopic moisture at 100°–110°C		7.402
Sand in air-dried clay		15.25
Refractoriness by Bischof's revised formula		0.32

The proportion of alumina and silica in this clay is such that the refractoriness would be high were it not for the injurious amount of fluxes contained, especially of magnesia, of which it contains more than any of the other clays analyzed. As it is, the refractoriness compares favorably with the Welch clay, and the clay may be used for all purposes for which the Welch clay is suitable. The quantity of this clay is apparently unlimited.

W. L. Wormac's clay.—Wormac's clay bed is in 10 S., 14 W., section 29, the northwest quarter of the northwest quarter, at an elevation of 260 feet above sea level. It outcrops four feet in thickness at the foot of the west bank of Freeo Creek. A small drain empties into the creek at this place, and the clay outcrops in this drain up to a spring which is ten feet above and which probably emerges just above the clay. The clay also forms the bed of the creek for some distance south (downstream). This clay is of a dark slaty blue color, with a waxy lustre when freshly exposed, but dries to a dull light drab.

The upper part of the bed, as exposed in the drain, is lighter in color. The clay in the creek bank breaks off in large roughly rectangular blocks from which small cubical pieces weather off, leaving a peculiar, angularly indented surface. The clay is plastic and the grit is very fine, being almost imperceptible.

Analysis of Wormac's clay.

		Per cent.
Silica	(SiO_2)	64.739
Alumina	(Al_2O_3)	16.569
Ferrous oxide	(FeO)	1.213
Ferric oxide	($Fe\ O$)	2.448
Titanic oxide	(TiO_2)	1.234
Lime	(CaO)	.837
Magnesia	(MgO)	1.535
Soda	(Na_2O)	1.395
Potash	(K_2O)	1.685
Phosphoric acid	(P_2O_5)	.107
Sulphuric acid	(SO_3)	1.138
Loss on ignition		7.334
Total		100.234
Hygroscopic water at 100°-105°C		6.89
Sand in air-dried clay		25.14
Refractoriness by Bischof's revised formula		.17

In appearance this clay differs widely from the other clays of Dallas county and the analysis shows a like difference in the chemical composition. The degree of refractoriness is too low to permit its being used as a potters' clay, without it be as an ingredient in other clays, and it is difficult to see how it could be beneficial as such. The resemblance of this clay to some of the Tertiary clays which are used in refining oils is quite marked, and its chemical composition is shown by the analysis to be not far different from the composition of those clays. It is quite probable that experiment would show it to work well as a refiner's clay, although this property depends upon the physical nature of the clay, to which the chemical composition gives little clue.

The Little Cypress Creek kaolin.—This bed crops out in the east bank of Little Cypress Creek, in 7 S., 17 W., section 26,

the southwest quarter of the northeast quarter, where the following section is exposed:

Section of the Little Cypress Creek kaolin bank.

	Feet.
Drab sandy clay overlain by soil, etc	7
Ferruginous shaly sandstone	0½
Drab sandy clay as upper stratum	5
White sandy kaolin	6

The elevation of the base of the section is 320 feet.

The depth exposed does not represent the full thickness of the bed for it forms the bed of the stream and extends to an unknown depth below. The bed passes into yellow sandy clay 100 yards down-stream. How far it extends up-stream cannot be told, for a few yards above the exposure the outcrop is covered with debris.

In J. E. Amis' well, about three-quarters of a mile southeast of here, a bed of white sandy clay and white sand, twenty feet or more in thickness, was struck at the same elevation. This may represent the kaolin bed. (See section of the well, p. 311.)

In appearance and texture this kaolin clay resembles the commercial scouring bricks, and it was with the thought of utilizing it for this purpose that the sample was collected. When rubbed between the fingers it has a lingering soapy feel, and at the suggestion of the State Geologist it was washed and analyzed to test whether this indicated a constituency of kaolin. This was done, with the following result:

Analysis of Little Cypress Creek kaolin (washed).

		Per cent.
Silica	(SiO_2)	62.166
Alumina	(Al_2O_3)	26.096
Ferrous oxide	(FeO)	.184
Ferric oxide	(Fe_2O_3)	.137
Titanic oxide	(TiO_2)	1.302
Lime	(CaO)	.051
Magnesium	(MgO)	trace
Soda	(Na_2O)	.252
Potash	(K_2O)	.364
Phosphoric acid	(P_2O_5)	trace
Sulphuric acid	(SO_3)	.553
Loss on ignition		9.067
Total		100.172
Hygroscopic moisture in unwashed sample		.298
Sand in clay dried at 100°-110°C		67 94
Refractoriness by Bishof's revised formula		4.81

In refractoriness this kaolin comes closely below the best washed kaolin from Brandywine Summit, Pennsylvania, which is used in the manufacture of fine chinaware. In chemical composition, however, this Arkansas kaolin differs widely from the Pennsylvania variety in having more silica and less alumina and water. It is impossible to say what effect this difference in composition will have on the physical behavior of the clay in firing, but, the refractoriness being so nearly the same, it is quite probable that the difference in composition will have no especially marked effect.

J. R. Kilmer's kaolin bank is in township 7 S., 17 W., section 10, the southeast quarter of the southeast quarter. A white clay outcrops in the bank of a drain at the elevation of 390 feet. The thickness exposed is between five and six feet. It contains a great deal of rather coarse sand and in its natural condition is only slightly plastic. In the dry state the sand easily separates from the finely divided clay mass, which gives a very soapy feel when rubbed between the fingers, indicating the presence of kaolin.

Analysis of Kilmer's kaolin (washed).

		Per cent.
Silica	(SiO_2)	52.269
Alumina	(Al_2O_3)	32.207
Ferrous oxide	(FeO)	.112
Ferric oxide	(Fe_2O_3)	1.657
Titanic oxide	(TiO_2)	1.505
Lime	(CaO)	.086
Magnesia	(MgO)	.028
Soda	(Na_2O)	.341
Potash	(K_2O)	.271
Phosporic acid	(P_2O_5)	trace
Sulphuric acid	(SO_3)	.169
Manganese oxide		trace
Loss on ignition		11.170
Total		100.280
Hygroscopic moisture at 100°–110°C		.912
Sand in material at 100°–110°C		38.57
Refractoriness by Bischof's revised formula		3.47

The analysis shows a kaolin of a very fair degree of refractoriness, the water contents coming more nearly up to the accepted formula for kaolinite than in the Little Cypress Creek kaolin. This kaolin will probably be found available for the same purposes as the Little Cypress Creek kaolin.

Table of analyses of Dallas county clays.

Clays analyzed.	Silica.	Alumina.	Ferric oxide.	Titanic oxide.	Lime.	Magnesia.	Soda.	Potash.	Loss on ignition.	Sand in air-dried clay.	Refractoriness by Bischof's revised formula.
Cheatham's clay	72.82	13.72	1.267	2.54	.63	.75	1.08	.96	5.76	50.30	.20
Bird's clay	66.42	21.19	1.956	1.02	1.13	.82	1.26	...	7.76	37.28	.45
Welch's clay	71.27	16.86	2.378	1.75	.73	.77	.46	.44	6.54	30.50	.31
Green's clay	68.03	17.19	3.589	1.49	.81	1.00	.54	1.00	6.31	35.80	.23
Tall's clay	62.343	20.631	4.082	1.556	.173	.668	.325	.729	9.339	16.73	.47
Crowder's clay	66.336	18.966	2.008	1.869	.256	.225	.800	.379	8.130	17.23	.60
Lavendar clay	50.653	25.450	6.481	2.591	.167	.604	.242	.742	13.100	3.46	.66
Ramsey clay	60.700	21.567	5.000	.447	.469	1.583	.297	1.526	8.608	15.25	.32
Wormac's clay	64.734	16.569	3.796	1.234	.837	1.535	1.395	1.685	7.334	25.14	.17
Little Cypress Creek kaolin	62.166	26.096	.341	1.302	.051	trace	.252	.364	9.067	67.94	4.81
Kilmer's kaolin	52.269	32.207	1.781	1.505	.086	.028	.341	.271	11.170	38.57	3.47

NOTE.—The exact location of the clays is given in their descriptions in the preceding pages.

Discussion of the analyses.—Of the preceding eleven analyses the first four were made by W. C. Riley, M. D., and the remaining seven by Prof. L. R. Lenox. It will be noticed that those clays analyzed by Dr. Riley show a much higher percentage of sand than those analyzed by Prof. Lenox. The determination of the percentage of sand is at best only approximate and a matter of individual judgment, and this accounts for the different percentages found. In two clays, which have to all appearances an equal amount of sand, the percentage of sand in the one as determined by Dr. Riley is about twice as great as the percentage in the other as determined by Prof. Lenox. In comparing the sand contents of the clays this should be borne in mind.

In each of the clays analyzed there was present a considerable amount of titanic acid and smaller quantities of sulphuric and phosphoric acids. Neither of these is taken into consideration in the formula devised by Bischof for calculating the refractoriness of clays. In determining the refractoriness of the clays of which analyses are given herein these constituents have been disregarded. It is highly probably that they exert some influence, possibly a strong one, on the fusing point of the clays.

Several of the clays showing the largest percentages of titanic acid were washed and the coarser and heavier parts examined under a microscope. Owing to the fragmentary condition of the particles it was not found possible to identify any of them except the quartz.

List of other occurrences of clay.

The following list of occurrences includes all the well sections of interest obtained while making this investigation, and in addition not only all those outcrops which came under the writer's observation, but likewise all localities where clay was reported to occur. The list is inserted here on account of the value of the data contained therein to possible prospectors.

It will be noticed that in a great many cases the clay has been described as sandy. Where this term has been used the

sand is usually present in quantity sufficient to overcome the plasticity of the clay, or rather to lower the degree of plasticity below the point necessary to render it available for ceramic purposes. In such cases a remedy lies in mixing with the sandy clay another clay whose degree of plasticity is high enough to bring the plasticity of the mixture up to the required standard. This will be the method adopted with most sandy clays which are of ordinary character and when clay of higher plasticity is readily available. Another remedy lies in washing out the excess of sand. This process entails so much additional expense that it will readily be seen to be impracticable, except in cases where the washed product is of a superior quality; in other cases the sandy clay could not compete with the abundant deposits which have not the disadvantage of an excess of sand.

The exposures will be taken up in the order of the townships, beginning at the northeast corner of the county. The elevations are given in feet above mean tide level of the Gulf of Mexico. In the case of wells the elevation is of the mouth; in natural sections the elevation of the base is given.

Township 7 S., 14 W.—Two feet of white plastic clay outcrops in a gulley about 600 yards west of Ivy post-office, and is overlain by six or eight feet of gravel. Occuring at the same elevation as, and less than half a mile distant from the Crowder clay (see page 298), it is probably continuous with it. Elevation 290 feet.

White plastic clay is reported on Gum Creek in the southwest quarter of section 29.

Township 7 S., 15 W.—In section 2, the southwest quarter of the northwest quarter, in a gully just west of the Tulip-Sandy Springs road, there is an exposure of 15 feet of clay resting on white sand. The lower seven or eight feet is white plastic clay of apparently fair quality. It is possible that the white sand is a sandy kaolin similar to the Little Cypress Creek kaolin. Elevation 360 feet. (See further page 286.)

Nancy Jones' well, section 2 southwest quarter. Elevation 390 feet.

	Feet.
Soil, gravel and sand.	8-10
White sandy clay	25
Dark clay	25

Lee Smith's well, section 4, northwest quarter. Elevation 450 feet.

	Feet.
Soil, gravel and red sandy clay	20
White sand	5
Tough, dark, sandy clay	25

Outcrop of sandy gray clay, half a mile east of the above. Elevation 380 feet.

Philip Phillips' well, section 5, southwest quarter of the northwest quarter. Elevation 500 feet.

	Feet.
Soil, gravel and sandy clay	15
Sand and clay interstratified	20
White, sandy clay	15

Chris. Lawrence's well, section 30, northeast corner of the southeast quarter of the northeast quarter. The well was bored and afterwards filled up. Reported by S. D. Green. Elevation 490 feet.

	Feet.
Soil, gravel and sand	25-30
Bluish clay, (and bottom not reached)	125

This well must pass through the Bird clay, but, being a bored well, no distinction is made between the plastic clay and the sandy white clay such as is found commonly in the upper part of this ridge.

Township 6 S., 16 W.—Rice's gin well, section 36, southeast quarter of the southwest quarter. Elevation 510 feet.

	Feet.
Soil, gravel and yellow sand	20
Bluish white clay, with interstratified beds of yellow sand..	28

This is the typical white sandy clay referred to above. A determination shows that the sand constitutes 64.29 per cent. of the whole mass.

G. A. William's well, section 36, northeast quarter of the southwest quarter. Elevation 510 feet.

	Feet.
Soil, gravel and sand	15
Sandy pipe clay	60
Sand below.	

Township 7 S., 16 W.—J. M. Holt's well, section 2, northeast quarter of the southeast quarter. Elevation 460 feet.

	Feet.
Soil and gravel	4
Sandy white pipe clay	40

J. S. Young's well, section 2, northeast quarter of the southwest quarter. Elevation 460 feet.

	Feet.
Soil and gravel	4
Sandy white pipe clay	40
Lignite	1½
Dark drab plastic clay	38

The lower 38 feet probably represents the Bird clay.

Mrs. E. A. Rice's place, section 15, northwest quarter of the northeast quarter. White plastic clay quite free from sand outcrops in the bed of a drain. It is reported that Bird pronounced this clay equal to the Bird clay. Elevation 415 feet.

In the Tulip-Arkadelphia road about one and one-fourth miles east of O'Neill's Mill, a bed from 20 to 30 feet in thickness of dark, putty-colored clay outcrops. This clay is very plastic, has little grit, and does not stick to the tongue. Elevation 520 feet.

Potters' clay of excellent quality is said to have been taken from the creek bank below the old mill-dam at Willow post-office. The place is now covered with water. Elevation 340 feet.

Potters' clay is reported in section 14, near the southwest corner, on a drain running into West Tulip Creek. Elevation 300 feet.

It is also reported that a bed from which Bird used to take clay occurs in section 29, on a drain running into Cypress Creek.

Township 7 S., 17 W.—J. E. Amis' well, section 36, northeast quarter of the northwest quarter. Elevation 360 feet.

	Feet.
Red sandy clay and gravel	15
Dark drab, plastic clay	5
White sandy clay and white sand	20+

This probably reaches the kaolin which outcrops on Little Cypress Creek (see page 303).

White plastic clay is reported in section 22 in the banks of a small drain and in section 35 in the bank of Little Cypress Creek.

Township 8 S., 15 W.—A white plastic clay outcrops in the bed of Canada Creek just below the ford of the Ivy-Princeton road. Elevation 250 feet.

A similar clay outcrops in the road a quarter of a mile south of the preceding and 30 feet higher in elevation.

On the same road, the Ivy-Princeton road, about three-quarters of a mile north of Princeton, is an outcrop of very sandy white clay. Elevation 260 feet.

In a gully beside the road, section 21, northeast quarter of the northeast quarter, a bed from two to three feet thick outcrops consisting of bluish white joint clay. This clay has little grit and does not cling to the tongue. It passes into sand to the north and into jointed and indurated sand of the same color 20 feet to the south. The joint cracks of the clay have filled up with sand carried by percolating water. Elevation 280 feet.

John C. Welch's well, section 19, northeast quarter of the northwest quarter, passes through about 30 feet of white sand. It may be that this is a sandy kaolin similar to those which have been described in the preceding pages. Elevation 350 feet.

An outcrop of plastic gray clay in road about 400 yards east of Welch's pottery. The thickness of this bed was not apparent. Elevation 440 feet.

Mrs. Lantorn's well, section 17, 440 yards west of the northeast corner. Elevation 310 feet.

	Feet.
Soil and gravel	6
White pipe clay	10
White sand	2
White clay	27

A load of this clay was tried by Mr. Welch, who says that it works very well.

P. N. Lantorn's well, section 8, southeast quarter of the northeast quarter. Elevation 370 feet.

	Feet.
Soil and gravel	2
Hard bluish clay	58
Lignite	8

L. D. Lantorn's well, section 5, middle of the south side. Elevation 480 feet.

	Feet.
Soil, gravel and sand	10
White pipe clay	28

Mrs. M. C. Green's well, section 5, southeast quarter of the northwest quarter. Elevation 480 feet.

	Feet.
Soil and gravel	8
White pipe clay	8
Bluish clay	27
Black "rock"	0½
Lignite	3
Sandy bluish clay	30

A. Whitener's well, section 3, southwest quarter of the northwest quarter. Elevation 480 feet.

	Feet.
Soil, gravel and sand	15
White clay	1
Lignite	1
White plastic clay	14

This lowest clay outcrops in a gully 50 yards west of the house.

Township 8 S., 17 W.—D. Ratliffe's well, section 2, southeast quarter of the southeast quarter. Elevation 290 feet.

	Feet.
Soil and red clay	4
White plastic clay	30
Dark plastic clay with ferruginous sandstone particles	10

There are scattering leaf impressions in both the light and the dark clays.

Bernard Dellamar's place, section 14, southwest quarter of the northwest quarter. An exposure of 12 feet of dark bluish drab clay. This clay is plastic and has little grit. Elevation 310 feet.

Outcrop of 15 feet of light blue plastic clay beside the road in northwest quarter of section 15. This clay weathers very much like the olive-green Tertiary marl. It has somewhat more grit than the clay which is most used for ware in this country. Elevation 320 feet.

J. R. Porterfield's well, section 17, southeast quarter of the northeast quarter. Elevation 350 feet.

	Feet.
Soil and gravel	17
Sand	1
Dark soft plastic clay with lignite flakes and nodules of iron pyrites	16

Potters' clay is reported near the center of section 34; also near the northeast corner of section 27, and again in the southeast quarter of section 35.

Well, section 36, northwest quarter of the northwest quarter. 75 feet of sand with lumps of plastic clay. Ends in white sandy clay similar to that overlying the lignite bed in this region. Elevation 280 feet. These lumps of clay embedded in the sandy strata seem to be a tolerably common mode of occurrence of the plastic clays, and have been reported in several wells.

Township 9 S., 14 W.—Pottery clay is reported in section 32, southwest quarter of the southeast quarter, and in section 30, southeast quarter of the southeast quarter.

Township 9 S., 15 W.—From two to four feet of bluish

white plastic clay outcrops in a gully beside the road in section 34, southeast quarter of the southeast quarter.

In the bank of Hay's Creek, section 5, southeast quarter of the northwest quarter, there is an outcrop of about 15 feet of grayish joint clay with considerable sand. Elevation 220 feet.

Potters' clay is reported in section 18, northwest quarter of the southwest quarter; also on Sand Creek, in section 20, northwest quarter.

Potters' clay is reported on the Bower's place, near center of section 22.

Clay which was pronounced good by Glass is said to occur in section 6, southwest quarter of the southwest quarter.

Grayish green potters' clay, ten to twelve feet in thickness, outcrops on the Princeton-Dalark road, in section 11. (J. C. Branner.)

Township 9 S., 16 W.—C. C. Williams' well, section 18, northeast quarter of the northeast quarter. Elevation 290 feet.

	Feet.
Soil and gravel	8
White pipe clay	20

Township 9 S., 17 W.—Frank Russell's well, section 1, southwest quarter, 15 feet of plastic clay in bottom. Elevation 290 feet. The same clay outcrops in a spring a few yards north of the well.

Township 10 S., 13 W.—In a gully beside the road, just south of Stony Point, in section 8, northeast quarter of the southwest quarter, a bed of white plastic clay outcrops, three or four feet of the bed is exposed. The same clay outcrops on the Ramsey road 400 yards west. A well 500 yards north and 20 feet higher penetrated a leaden colored sandy clay, containing leaf impressions. Elevation 270 feet. (J. C. Branner.)

A light colored pottery clay outcrops in the gully east of the road, in section 20, northeast quarter of the northeast quarter. (J. C. Branner.)

Township 10 S., 14 W.—White plastic clay is reported in section 5, northwest quarter of the northeast quarter, and in section 7, the northwest quarter of the northwest quarter.

A. B. Smith's well, section 8, southeast quarter. Elevation 265 feet.

	Feet.
Soil, red clay and gravel	12
Bluish joint clay	40
Red sandy clay	8

This clay evidently passes into sand for a well at the same elevation 100 feet away shows.

	Feet.
Soil and gravel	12
White fine-grained sand	33

Potters' clay in section 8, southeast quarter. Ten feet is exposed in the road and in the banks of a stream which flows into Freeo Creek. Elevation 250 feet.

Potters' clay outcrops in the Little-Bay Princeton road in the southwest quarter of section 16. Elevation 265 feet.

Smith place, section 17, southeast quarter of the northwest quarter. Two or three feet of white plastic clay is exposed in the bank and bed of Freeo Creek, immediately above the ford. Elevation 230 feet.

R. H. Barner's well, section 20, northeast quarter of the northeast quarter. Elevation 275 feet.

	Feet.
Red clay and sand	7
Blue joint clay, sandy towards bottom	34

Ten or fifteen feet of grayish pottery clay outcrops in the road in the northwest quarter of section 34. Elevation 270 feet.

Township 10 S,, 15 W.—In a gully beside the road, north of a church, section 2, northwest quarter, is an exposure of eight to ten feet of bluish white plastic clay. Elevation 235 feet.

J. T. Shankle's well, section 7, southeast quarter of the northwest quarter. Elevation 300 feet.

	Feet.
Red sand and clay	20
White pipe clay	10
Dark lumpy clay	10

A bored well at the same elevation showed 22 feet of the

dark clay and stopped in lignite, according to the man who put it down. The dark clay contains a few leaves.

J. W. Richardson's place, section 9, southeast quarter of the southeast quarter. Ten feet of gray plastic clay outcrops beside the road. Elevation 240 feet.

Potters' clay 15 feet in thickness outcrops in a gully in the southeast quarter of the southwest quarter of section 16, and is underlain by 10 or 20 feet of white sand. Elevation 260 feet.

Potters' clay is reported in a well at the gin in section 18, northwest quarter of the southwest quarter.

Pottery clay outcrops in the road in the northwest quarter of section 21. Elevation 260 feet.

Potters' clay is reported in section 22, northwest quarter.

Township 10 S., 16 W.—W. M. Walsh's well, section 1, northeast quarter of the northwest quarter. Elevation 265 feet.

	Feet.
Red clay and sand	8
Black clay with leaf impressions	10
Yellow sand and clay	45
White plastic clay	4

Well stopped in the last stratum without penetrating it.

Clay on Peterson's place, section 12, northeast quarter of the southwest quarter. A foot of light-colored clay with some grit is exposed in a drain. Elevation 230 feet.

James Goodgame's well, section 13, northwest quarter of the northeast quarter. Elevation 240 feet.

	Feet.
Soil	4
Pipe clay	17

R. E. Hogg's well, section 13, southwest quarter of the southeast quarter. Elevation 310 feet.

	Feet.
Soil and gravel	10
Potters' clay	2–3
Sand below.	

The pottery industry in Dallas county.

The pottery industry in Dallas county has been mainly confined to the operations of the Bird brothers and their ap-

prentices. The first pottery was established by them, and the only pottery now in the county is owned and operated by John C. Welch, who learned the potter's trade under William Bird.

The first pottery was set up in 1843, by two of the brothers, Joseph and Nathaniel Bird.

In 1844 James Bird, another brother, erected a pottery just over the line in Grant county, in the southeast quarter of the southeast quarter of section 23, 6 S., 16 W. He had burned but a few kilns when he sold out, and the business was discontinued. He used clay from a bed close by the old shop.

William Bird, the last of the four brothers, is the one who has been most concerned with this industry. He started his first pottery in 1843, in the southwest quarter of the northwest quarter of section 7, 7 S., 15 W. His clay came from the Butler bed. He continued steadily at work here until 1851 or 1852, when he moved his shop to the site now occupied by John C. Welch's pottery, northwest quarter of the southwest quarter of section 17, 8 S., 15 W. In conjunction with the pottery a grist mill and a saw mill were set up by his brothers, Joseph and Nathaniel. He operated this pottery until 1861, when he sold out to Welch. While running here he used clay from the Butler bed, and later from the Cheatham beds also. Bird started another pottery at the close of the war, on what is known as the Bird place, in 7 S., 15 W., section 6, the southwest quarter of the northwest quarter. He continued here until about 1881, when he left the state. He afterwards returned and followed his trade in Malvern. While at the Bird place he used clay from the Butler bed, also from the Bird bed on the Bird place and from Gum Bottoms. Bird has the reputation among the older inhabitants of the county of making very fine, durable ware.

John C. Welch, as before noted, learned the trade under William Bird, and in 1861 bought him out. Welch has continued the business at the same place. The capital invested in this business, exclusive of location, is about $150. The kiln has a capacity of 1,500 gallons. Two wheels are run and the

average annual output is about 10,000 or 15,000 gallons. The product is in the form of jugs, jars, churns, and crocks. These find a market in neighboring towns: Pine Bluff, Camden, Warren, Monticello, El Dorado, Magnolia, etc. During the last four years only one kiln has been burned, and this was a small one to supply the local market in 1890. Mr. Welch at first used clay from the Cheatham beds, but later found and worked the Welch bed. His ware is hard, close-bodied and thin. Some object that it is too thin to be durable.

Nathaniel Culberson worked a while with Welch, and between 1858 and 1865 ran a pottery near the middle of section 24, 8 S., 15 W. He used clay from the Cheatham beds. Fragments from the old kiln show a rather thick, porous ware.

In 1859 or 1860 a foreigner named Etl, established a pottery about three-quarters of a mile north of the preceding, and operated it for about three years. Besides ordinary crockery he made flower pots with vines and flowers in relief on the sides. He used clay from the Cheatham beds.

In 1870 Lafayette Glass, after acquiring the trade under Welch, set up a pottery in the northeast quarter of the southeast quarter of section 29, 8 S., 15 W. He operated here for a year and then removed to Benton and became the pioneer potter of that place. While in Dallas county he used clay from the Sullenbarger bed.

Between 1874 and 1876, E. A. Munn, a brother-in-law of Welch, ran a pottery in the northeast quarter of the southeast quarter of section 12, 8 S., 16 W. He left there and established a pottery at Malvern. He used clay from the Welch bed. Fragments about the old kiln show a fine, hard, and close-bodied ware.

BIBLIOGRAPHY OF THE GEOLOGY OF ARKANSAS.

By John C. Branner.

The following authors' list includes nearly all the titles referring to the geology of the State. The names are arranged in alphabetic order. Newspaper articles are not included in the list except those publisheed by W. F. Roberts in the *Age of Steel* of St. Louis. Those titles are listed chiefly because Mr. Roberts was at one time State Geologist of Arkansas, and as he published no official report, the articles are believed to represent his views of the geology of the State. There are excepted also a few official reports that have been published in newspapers only. There are probably many short articles upon Brookite and other mineral species found in Magnet Cove that it has not been possible to consult. So far as those papers are known they are referred to in the report upon Igneous Rocks (Vol. II for 1890).

Maps of the United States on which attempts have been made to show the geology of Arkansas are not mentioned except in the cases of Maclure's and Lyell's. The Annual Reports of the Chief of Engineers of the United States Army contain a great deal of important information bearing upon the geology, especially upon the post-Tertiary geology of the State. No attempt is made to include the titles of those papers. They can be readily found by referring to the volume of indexes of those reports. Purely statistical information such as may be found in census reports is not attempted.

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The following list includes all of the official reports made by the several Geological Surveys carried on by the State of Arkansas.

The distribution and sale of the Reports are in the hands of the Secretary of State. In 1893 the Legislature provided that the Secretary of State should distribute one copy each of all volumes published after May, 1892, to "colleges and high schools of this state, and universities and scientific institutions of other states." He was also supplied with a limited number of all volumes by the Survey under J. C. Branner "for distribution to scientists and capitalists." It was provided, however, "that before the Secretary of State shall be authorized to distribute any of the reports to scientists or capitalists * * * * * he shall require the applicant to state in writing that he is a scientist or capitalist, and that he wishes the reports to aid him in investigating the mineral resources of the state." It was further specified "that the Secretary of State shall not be authorized to distribute any of the reports to scientists or capitalists until the postage or express charges on same have been paid" (Acts of Arkansas, 1893, pp. 226-7).

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